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NATIONAL DAM INSPECTION PROGRAM. LOCUST CREEK DAM (TUSCARORA LA--ETC(U)
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Contract No. DACW31-78-C-0048

LEVEL II

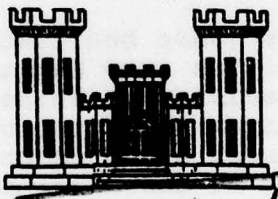
(1)

SCHUYLKILL RIVER BASIN

LOCUST CREEK DAM
SCHUYLKILL COUNTY, PENNSYLVANIA
NATIONAL I.D. NO. PA 00699

(6) PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Locust Creek Dam (Tuscarora Lake), (PA-00699), Schuylkill River Basin, Locust Creek, Schuylkill County, Pennsylvania. Phase I Inspection Report.



(15) DACW31-78-C-0048

Prepared by:

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Submitted to:

DEPARTMENT OF THE ARMY
Baltimore District, Corps of Engineers
Baltimore, Maryland 21203

ORIGINAL CONTAINS COLOR PLATES: ALL DDC REPRODUCTIONS WILL BE IN BLACK AND WHITE.

(11) August 1978

(12) 95p.

PHASE I INSEPCTION REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam: Tuscarora State Prk Dam
County Located: Schuylkill County
State Located: Pennsylvania
Stream: Locust Creek
Coordinates: Latitude 40° 48.3' Longitude 76° 00.4'
Date of Inspection: 1 August 1978

Tuscarora State Park Dam is owned and maintained by the Department of Environmental Resources. The dam was designed by Berger Associates, Incorporated, of Camp Hill, Pennsylvania, for the U.S. Department of Agriculture, Soil Conservation Service. The facility is considered to be in good condition and well maintained. The dam is classified as a "High" hazard potential structure consistent with its potential in the event of failure for extensive property damage and possible loss of life downstream. The dam is also classified as an "Intermediate" size dam based on its 98 foot height and 1,965 acre-feet normal storage capacity.

The design data and other supplemental information pertinent to this dam were sufficient to evaluate the embankment and appurtenant structures. Although hydrologic and hydraulic computations were unavailable, approximate methods were used to compute the capacity of the spillway. These computations are presented in Appendix C, and the results indicate that the dam will pass the probable maximum flood (PMF) without overtopping. Therefore, the spillway for this structure is considered to be "Adequate".

A visual inspection of the dam and reservoir facilities detected no deterioration of the embankment or its appurtenant facilities to suggest an impending hazardous condition. Some sloughing and deterioration of the emergency spillway rock channel was observed. This condition is not considered to be of major concern, but should be monitored.

Considering the adjudged good condition of the dam, the recommendations presented below are suggested to insure that the dam continues to function as designed and to insure that residents downstream are notified when impending high flows are expected along the creek. These recommendations are presented in order of priority, but does not infer that the latter recommendations are not important.

1. The plunge pool below the principal spillway should be checked after each severe storm for movement of rock and undermining beneath the discharge pipes.

2. The side slopes of the emergency spillway should be checked at least once per year and talus accumulations removed.

3. Woody vegetation should be removed yearly from the downstream slope of the embankment and the emergency spillway.

4. An alternate means of gaining access to the dam during periods of flow over the emergency spillway should be established so the dam can be monitored.

Recommendations concerning the operation and maintenance of the dam are presented as follows.

1. A formal procedure of observation and warning during periods of high precipitation should be developed because of the possibility of extensive property damage downstream during periods of high flow.

2. Although the Owner's operation and maintenance procedure is quite comprehensive, an inspection checklist should be incorporated into this procedure to insure that all items are inspected and maintained in good operating condition.

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APPROVED BY:

28 Sep 78
Date

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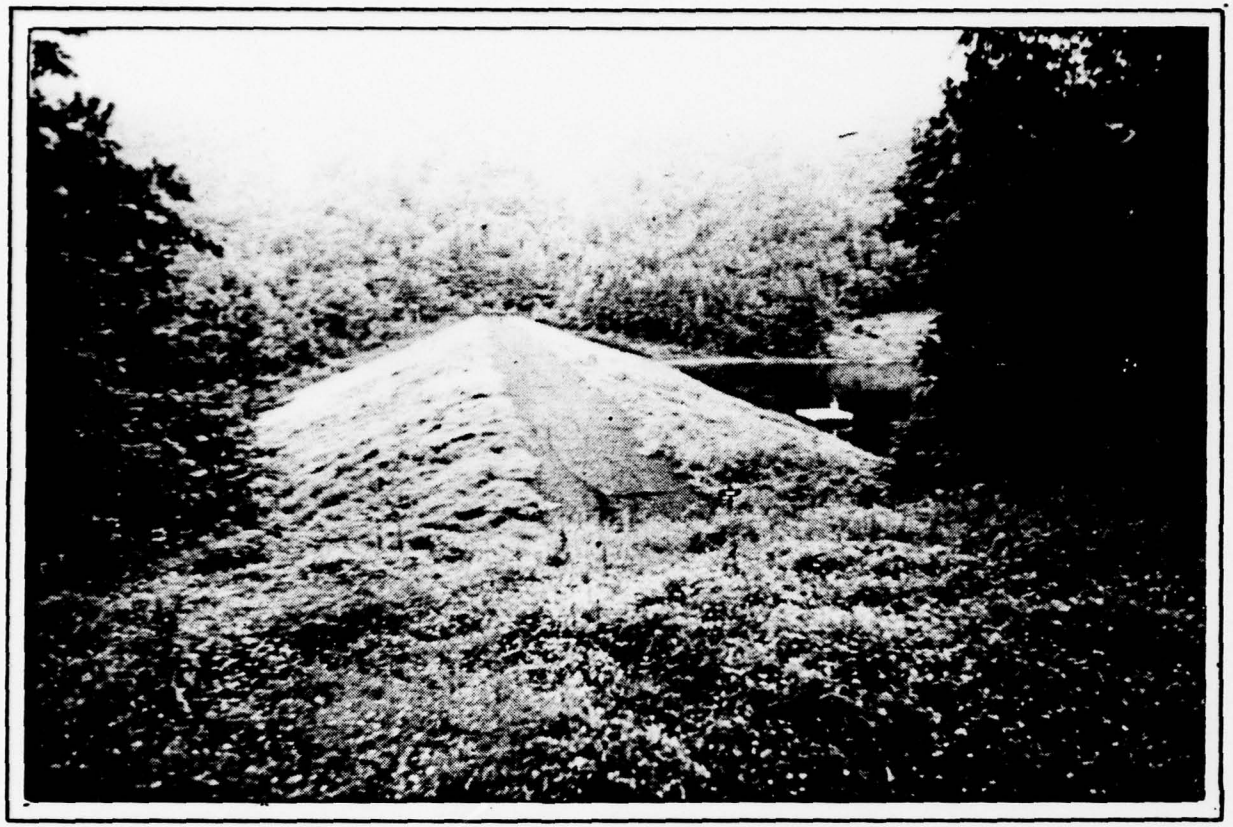
District Engineer



OVERVIEW
LOCUST CREEK DAM, SCHUYLKILL COUNTY, PENNSYLVANIA

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
LOCUST CREEK DAM
(TUSCARORA STATE PARK DAM)
NATIONAL ID NO. PA 00699
DER NO. 54-170

SECTION 1
PROJECT INFORMATION

1.1 General.

a. Authority. The Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of inspection of dams throughout the United States.

b. Purpose. The purpose of the inspection is to determine if the dam constitutes a hazard to human life or property.

1.2 Description of Project.

a. Dam and Appurtenances. Tuscarora State Park Dam is a rolled earthen embankment with a downstream inclined filter blanket and random rock-fill zone. The dam has a maximum height of 98 feet, a crest width of 26 feet, a length of 750 feet, and a grout curtain and cutoff trench excavated into rock. The cutoff trench location varies from beneath the centerline to as much as 70 feet upstream of the centerline. A grout curtain extends from the base of the cutoff trench to a maximum depth of 40 feet. The inclined filter blanket is connected to a 2-foot thick horizontal filter blanket which drains into a downstream toe drain. Two collector pipes on either side of the principal spillway outlet drain the toe. The upstream slope is 2.85:1 (H:V) from the crest to elevation 1006.6. Below elevation 1006.5 the slope increases to 3:1 (H:V). The entire upstream slope is protected by a four-foot layer of riprap over a two-foot filter blanket. The downstream slope is 2.5:1 (H:V).

The principal spillway intake riser, located upstream of the centerline, has a 6 foot by 6 foot drop inlet weir at elevation 1007.5. The drop inlet discharges through a transition section to a 42-inch precast concrete conduit and discharges into a plunge pool downstream.

The pond drain intake structure is at the upstream toe with an invert elevation of 953.4. Water passes through trash racks into a 24-inch diameter precast concrete conduit and discharges through the common 42-inch pipe of the principal spillway. Discharge through the pond drain is controlled by a 2 foot by 2 foot square sluice gate at the base of the intake riser with an invert elevation of 951.0.

The precast concrete conduit common to both the principal spillway and pond drain discharges at an invert elevation of 947.1. Typical plans, profiles and section of the intake riser and pond drain are shown in Appendix E on Plates 4 through 7.

The emergency spillway was excavated into rock left of the dam as shown in Appendix E on Plate 2. The emergency spillway is 150 feet wide with a length of 760 feet. The emergency spillway control section is at elevation 1029.0.

b. Location. Tuscarora State Park Dam (Locust Creek Dam) is located across Locust Creek approximately 0.8 miles west of, and upstream from, the confluence of Locust Creek with the Little Schuylkill River. It is also approximately 2.5 miles northwest of the town of Tamaqua, Pennsylvania. The dam is located in Rush Township, Schuylkill County, Pennsylvania. The dam site and reservoir are shown on USGS Quandrangle entitled: "Delano, Pennsylvania" at coordinates N 40° 48.3' E 76° 00.4'. A regional location plan of Tuscarora State Park Dam is enclosed as Plate 1, Appendix E. There are two dams (Locust Lake Dam and Cordorus Dam) upstream, which are discussed in Section 5 of this report.

c. Size Classification. The dam is classified as an "Intermediate" dam consistant with its 98 foot height and 1,965 acre-feet normal storage capacity.

d. Hazard Classification. The dam has a "High" hazard classification because of the potential for extensive property damage and loss of life downstream.

e. Ownership. The dam is owned and maintained by the Department of Environmental Resources (DER). All correspondence should be issued to Mr. Arthur Moeller, Park Superintendent, RD #1, Barnesville, Pennsylvania 18214.

f. Purpose of Dam. The reservoir was designed for a combination of recreation and flood control.

g. Design and Construction History. The dam was designed by Berger Associates, Inc. of Camphill, Pennsylvania, for the U.S. Department of Agriculture, Soil Conservation Service (SCS). The "Report Upon the Application of the Department of Forests and Waters, Division of Flood Control" was issued on 1 June 1962, by Mr. J. J. Ellam, Hydraulic Engineer and Mr. C. H. McConnell, Chief Engineer on behalf of the State of Pennsylvania. The construction permit was issued on 25 May 1962 by the Commonwealth of Pennsylvania.

Construction began in October 1962, by the Forest Company of Mechanicsville, Pennsylvania. By 20 November 1963, the earth embankment was completed but the spillway was unfinished. Shortly thereafter, a directive was issued by the State of Pennsylvania to continue construction throughout the winter in order that the emergency spillway would be completed before the spring thaws and high inflow volumes. The emergency spillway could not be excavated until after the embankment was completed, as the only access road crossed the emergency spillway location. In June 1964, all construction ceased because the Forest Company reportedly went bankrupt. Additional funds were obtained and the dam

and appurtenances were completed by the Reo Company of Barnesville, Pennsylvania. The official completion date is 31 December 1964.

Inspection of the dam following Tropical Storm Agnes, June 1972, revealed cracks in the 42-inch principal spillway conduit. In the summer of 1973, the Corps of Engineers prepared specifications to grout the conduit cracks. This work was performed by the Royal International, Inc. of Bridgeport, Pennsylvania. Details of the grouting program are presented on Plate 9 of Appendix E.

The design engineers', Berger Associates, Inc., files were researched but construction records could not be located.

h. Normal Operation Procedures. Under normal conditions there is no dam tender required as both the principal and emergency spillways are ungated. Water is maintained at the normal pool elevation by the intake riser weir at elevation 1007.5. It was reported by park personnel that the pond drain valve is exercised at least twice per year. At that time, the valve is cleaned, lubricated, and trash is removed from around the principal spillway trash racks. It is also reported that divers periodically check the pond drain trash racks for trash and other debris.

The emergency spillway has a crest elevation of 1029.0. To date, the emergency spillway has not discharged flood water, but water has been as close as 2 feet from the crest of the spillway (June 1972). Typical cross-sections of the principal spillway and emergency spillway are enclosed in Appendix E as Plates 4 through 8.

1.3 Pertinent Data.

A summary of pertinent data for Tuscarora State Park Dam is summarized as follows:

a.	Drainage Area (sq. miles)	13.1
b.	Discharge at Dam Site (cfs)	
	Maximum Known Flood (June, 1972)	425
	Maximum through principal spillway	450
	Maximum through emergency spillway	22,000
c.	Elevation (feet above MSL)	
	Top of Dam	1043.5
	Emergency Spillway Crest	1029.0
	Principal Spillway Crest	1007.5
	Conservation Pool	1008.0
	Maximum Design Pool	1036.4

	Pond Drain Entrance	
	Invert Elev.	953.4
	Principal Spillway Exit	
	Invert Elev.	947.1
d.	Reservoir (miles)	
	Length at Normal Pool	1.5
	Fetch at Normal Pool	1.3
e.	Storage (acre-feet)	1,965
	Conservation Pool	4,640
	Crest of Emergency Spillway	
	Maximum Design Pool	6,000
	Top of Dam	7,000 est.
f.	Reservoir Surface (acres)	
	Normal (Recreation) Pool	96.1
	Flood Water Detention Pool	159.9
g.	Dam Data	
	Type	Rolled earth fill
	Length	750 feet
	Height	98 feet
	Crest Width	26 feet
	Volume	250,000 cubic yards
	Side Slopes	
	Upstream	
	Crest to Elev. 1006.6	2.85:1 (H:V)
	Below Elev. 1006.6	3:1 (H:V)
	Downstream	2.5:1 (H:V)
	Cutoff Trench	Grout trench located either along or upstream of centerline
	Grout Curtain	Single line split-spaced grout curtain. Max. depth approx. 40 feet
h.	Diversion	Stream flow routed around riser and then through the pond drain
i.	Regulating Facilities	
	Pond Drain	24-in. concrete pipe with trash racks at entrance
	Gate	2 ft. x 2 ft.
	Pipe Length	137 feet
	Principal Spillway	
	Type	6 x 6 feet drop inlet weir with anti-vortex device
	Discharge Pipe	42" concrete pipe
	Length of Pipe	368 feet

Emergency Spillway	
Type	150 foot wide trapezoidal channel cut through rock in left abutment
Length	760 feet

SECTION 2
ENGINEERING DATA

2.1 Design.

a. Data Available. A summary of engineering data is presented in the checklist attached as Appendix A. Principal documents containing pertinent data used for this report are listed below.

1. "Report Upon the Application of the Forests and Waters, Division of Flood Control" by the State of Pennsylvania, dated 1 June 1962, prepared by Joseph J. Ellam, Hydraulic Engineer.

2. "Permit" prepared by the Commonwealth of Pennsylvania, Department of Forests and Waters, Water and Power Resources Board, dated 25 May 1962.

3. Construction reports for Locust Creek Dam prepared by Mr. V. M. Beard, Chief, Division of Flood Control, Department of Forests and Waters, from April 1963 through December 1963.

4. "Inspection Report" prepared by the State Parks Region No. 4. Dates range from 1972 through the present.

5. "Construction Specifications" prepared by the Northeast Division of the Soil Conservation Service, dated 1 December 1964 and 1 September 1965.

6. "Bid Form and Special Requirements for Tuscarora State Park Dam, Grouting Outlet Conduit", Locust Creek, Schuylkill County Pennsylvania, File No. R54:3; Contract No. R54:3-102.1; issued 31 December 1973, prepared by the Commonwealth of Pennsylvania, Department of Environmental Resources, Offices of Resources Management, Bureau of Resources Programming, Harrisburg, Pennsylvania.

7. Drawings labeled "Final Construction" prepared by Berger Associates, Inc. for the Soil Conservation Service, 10 sheets.

8. General project features report was prepared by Berger Associates, Inc., Harrisburg, Pennsylvania. Data includes area geology, sub-surface exploration and testing, basis for design, emergency spillway, outlet works, conduit areas, evaluation of construction materials, cost estimates, and a series of soil test results.

9. Miscellaneous memos, correspondence and other pertinent data included in the State files.

b. Design Features. A complete description of the design features of this project is discussed in Section 1.2, "Description of Project".

2.2 Construction.

A description of the available construction history as determined from Department of Environmental Resources files and State Park representatives is described in Section 1.2.

2.3 Operational Data.

There are no operational records maintained. There are no minimum flow requirements for the downstream channel. There are no water level measurements or rainfall records maintained within this watershed. A combined operations and maintenance manual was located at the Park office and reviewed. Pertinent items from this manual are included in this report.

2.4 Evaluation.

a. Availability. All engineering data produced in this report and studied for this investigation was provided by either the Department of Environmental Resources, the Soil Conservation Service, or Berger Associates, Inc.

b. Adequacy. Data included in the State files together with the supplemental data received from other sources and verbal information received from Park representatives is considered adequate to evaluate the dam and appurtenant structures.

c. Validity. There is no reason to question the validity of this data.

SECTION 3
VISUAL INSPECTION

3.1 Findings.

a. General. The observations and comments of the field inspection team are contained in the checklist enclosed herein as Appendix B, and are summarized and evaluated as follows. In general, the dam and its appurtenant facilities are in good condition and well maintained. Tuscarora State Park employees patrol the reservoir and maintain the appurtenant facilities. This maintenance includes periodic exercising of the pond drain valve, removal of debris from trash racks, and periodic inspections of the facilities to assure that they are operating, or will operate, properly.

b. Dam. During the visual inspection, there were no indications or evidence observed of distortions in alignment or grade that would be indicative of movement of the embankment or the foundation. A careful inspection of the downstream slope and adjacent downstream areas disclosed no seepage flows. However, as shown on Sheet 5a of Appendix B, a topographic low was noted at the downstream toe of the dam. Similarly, standing water was noted further downstream as shown on Sheet 5a. These topographic lows have been documented as being associated with construction activities during the pipe grouting work in 1973 and the 1964 construction, respectively.

There were no signs of riprap distortion, movement, or deterioration. The quality of the rock is good; however, the rock is principally composed of shale materials which are expected to weather and decompose over the years. Signs of decomposition in the form of slaking and crumbling are already in evidence.

c. Appurtenant Structures. At the time of the inspection, water was flowing over the crest of the principal spillway. The accessible portions of the intake riser were thoroughly inspected and observed to be in good condition with no signs of distress, concrete spalling, or other indications of poor construction or movement of the riser. Due to the level of the water, the inside of the riser could not be inspected. The pond drain sluice gate was exercised and observed to work properly. The valve was clean, painted, and well lubricated.

The discharge pipe could not be inspected because of water flowing over the principal spillway. It is noted that representatives from the Department of Environmental Resources (DER) periodically inspect this pipe.

The plunge pool was inspected and found to be in good condition. Some riprap movement was observed as was observed by DER during previous inspections. The toe drain discharge pipes are below the plunge pool water level and could not be inspected. The riprap-lined discharge channel between the plunge pool and the natural stream bed was inspected and found to be quite stable and in good condition.

The emergency spillway located left of the embankment was inspected and observed to be in good condition. Scars from previous slides principally along the left wall of the channel were observed. Some minor accumulations of rock talus were observed along the base of both sides of the channel. Surface degradation of the rock is also evident. Some vegetation is beginning to grow in the crevices and will further degrade these materials. It is not expected that this degradation will significantly affect the performance of the spillway within the near future. However, additional slope sloughing should be expected during the life of this structure. The drop-off at the end of the emergency spillway was inspected and some recent cutting of trees was observed. The channel bottom is fairly stable and in good condition.

d. Reservoir. Reconnaissance of the reservoir disclosed no evidence of siltation, slope instability or other features that would significantly affect flood storage capacity of the reservoir. The drainage basin surrounding the reservoir was inspected and assessed to be quite stable and well-vegetated. A few residential areas are located along the stream channel in the valleys and are predominantly in the form of farms and open land. Development within this basin is expected to be slow during the next several years. Locust Lake and Cordorus Dams are located upstream and are discussed in Section 5.

e. Downstream Channel. As shown on Plate 1, Appendix E, Locust Creek discharges into the Little Schuylkill River approximately one stream mile below the dam. At the confluence of these streams, Locust Creek passes under one bridge which is shown on Plate 1, Appendix E. Between the dam and the Little Schuylkill River there are no residential dwellings. In the event of failure it is expected that this bridge would be destroyed together with railroad bridges across the Little Schuylkill further downstream. In the event of failure of the dam, property damage and possible loss of life could occur at Tamaqua or at the Sunoco Oil storage area located just north of Tamaqua.

3.2 Evaluation.

The inspection of the dam disclosed no evidence of apparent past or present movement that indicates existing instability of the dam, principal or emergency spillways. The pond drain sluice gate was exercised and found to be operating properly. It was cleaned, painted and well lubricated. The interior portions of the principal spillway intake riser and discharge pipe could not be inspected due to flow through the system. The plunge pool was inspected and some rock displacement was noted but is not considered to be a major deficiency.

The emergency spillway was inspected and observed to be in relatively good condition. Traces of previous side hill failures of the shale slopes was noted and some talus was observed at the base of the slope. Some deterioration and weathering of the spillway channel was noted but is not considered to be significant. Vegetation is beginning to develop in the cracks and the joints of the spillway walls and spillway channel. This vegetation should be periodically removed to minimize further deterioration.

There was very little debris noted along the reservoir shoreline near the emergency spillway and at the trash racks of the principal spillway. Some debris was noted along the upstream slope of the dam adjacent to the principal spillway. This debris was removed from the spillway and placed on the slope. Park officials reported that debris is periodically collected and burned on the slope. Some minor accumulations of debris was noted around the base of the trash racks but did not significantly affect the inflow over the weirs. Based on these visual observations and discussions with the park representatives, it is evident that park employees remove this trash on a regular basis.

SECTION 4
OPERATIONAL PROCEDURES

4.1 Procedures.

Operational procedures are discussed in detail in Section 1.2. As stated in Section 1.2, the operation of the dam does not require a dam tender. Under normal conditions, flow discharges over the principal spillway weir (elevation 1007.5). Thereafter, excess water is stored up to the emergency spillway crest (elevation 1029). To date, water has never flowed over the emergency spillway, but has been within 2 feet of the crest (June 1972). The reservoir can be drawn down or drained by opening the sluice gate at the base of the riser pond drain. The sluice gate valve is located at the top of the riser. Operational and maintenance procedures are located at the park office and were reviewed by the inspection team.

4.2 Maintenance of the Dam.

The dam is maintained by the Tuscarora State Park employees who periodically check the embankment, remove woody vegetation as necessary, and perform other minor repairs.

4.3 Maintenance of Operating Facilities.

Park employees periodically inspect the principal and emergency spillways for accumulations of trash and other debris. The trash racks are cleaned at least twice per year and the material is burned on the upstream slope of the embankment. The pond drain valve is exercised at least twice per year, normally in the spring and the fall. During this period the pond drain is lubricated and painted if necessary.

4.4 Warning Systems in Effect.

The representative for the Tuscarora State Park reported that there are no formal warning systems or procedures established to be followed during periods of heavy rainfall. If hazardous conditions develop or if high flow conditions are anticipated, the local Civil Defense Authority would be notified by park representatives.

4.5 Evaluation.

It is judged that the current operating procedure, which does not require a dam tender, is a realistic means of operating the relatively simple control facilities of Tuscarora State Park Dam. It is obvious, based on the field inspection,

that regular maintenance of the principal spillway is performed by park employees. Park employees also maintain a complete record of all inspections made and a description of what was inspected and deficiencies noted during the inspection.

It is noted that access to the dam is limited. Construction and maintenance vehicles must use the downstream spillway channel to approach the dam. Obviously, if the emergency spillway is flowing, access to the dam is prevented. It is concluded that other means of access to the dam is required for the purpose of monitoring flows. Since there are no formal warning procedures, it is recommended that a procedure be developed so downstream residents, particularly in the town of Tamaqua, be amply warned of possible high flows or potentially hazardous conditions.

SECTION 5
HYDROLOGY/HYDRAULICS

5.1 Evaluation of Features.

a. Design Data. There was no complete hydrologic/hydraulic design package available for review. Limited information was available in the State files. Information was obtained from the designer, Soil Conservation Service (SCS), and from the Park Superintendent.

The watershed is long and narrow, approximately 8 miles long with an average width of 1.7 miles, and has a total area of 13.1 square miles. Elevations range from 1780 in the upper reaches to 1008 at the normal pool elevation. The watershed is presently about 50 percent wooded and 10 percent residential, with the remainder as open/farm land. Some residential development is taking place, but is not expected to be extensive.

The watershed also contains two upstream reservoirs, Locust Lake Dam (also a State Park), and Cordorus Dam. Locust Lake Dam is about 5.5 miles upstream of Tuscarora State Park reservoir and controls 1.6 square miles of drainage area. This dam was also inspected under the National Dam Inspection Program. It was determined to have an "Adequate" spillway capacity and be able to pass the PMF without overtopping. Cordorus Dam controls about 1.4 square miles and is located about 4 miles upstream of Tuscarora State Park reservoir. The Corps of Engineers, Baltimore District, reports that Cordorus Dam will have little influence and may be neglected in the hydrologic analysis.

In accordance with the criteria established by the Federal (OCE) Guidelines, the recommended spillway design flood for this "Intermediate" size dam and "High" hazard potential classification is the probable maximum flood (PMF).

b. Experience Data. No reservoir water levels or rainfall records are maintained. Tropical Storm Agnes, in June 1972, is frequently the storm of record for eastern Pennsylvania. The reservoir level was estimated to be at elevation 1027.5 with a discharge of about 425 cfs during Tropical Storm Agnes.

c. Visual Observations. On the date of the inspection, no conditions were observed that would indicate that the outlet capacity would be reduced during a flood occurrence. Observations regarding the condition of the downstream channel, spillway conditions and reservoir are located in Appendix B.

d. Overtopping Potential. The preliminary design report stated that the effect of the upstream dams, Cordorus and Locust Lake, could be neglected, as the drainage area controlled by each was small. That assumption is conservative if they do not fail during passing of the PMF. Cordorus Dam has limited storage, and the inspection of Locust Lake Dam conducted under the National Dam Inspection Program concluded that Locust Lake Dam would not fail during passing of the PMF. Therefore, both may be neglected.

Inflow-outflow hydrographs from SCS indicate a maximum inflow of 33,200 cfs and a maximum outflow of 28,000 cfs. As no calculations were available for review, information supplied was checked by approximate methods (see Appendix C). It was concluded that the supplied hydrographs are adequate and the dam would not be expected to overtop during the PMF event.

e. Spillway Adequacy. The spillway systems for this dam are considered to be "Adequate", as the dam has been designed to pass the PMF without overtopping. The tailwater is estimated to be 80 feet or more below the top of the dam during passing of the PMF.

f. Downstream Conditions. Approximately 3,700 feet downstream of the dam, Locust Creek joins the Little Schuylkill River. Immediately upstream of the confluence, a highway bridge crosses Locust Creek, which is subject to flooding. The bridge is expected to flood at discharges of between 5,400 cfs and 9,100 cfs, depending on the water surface elevation in Little Schuylkill River.

Tuscarora State Park Dam was built, in part, as part of the flood control program of the Little Schuylkill Watershed. About 2.3 stream miles downstream of the confluence of Locust Creek with the Little Schuylkill River, Little Schuylkill River flows through the town of Tamaqua. A section of the Work Plan prepared for SCS on the Little Schuylkill Watershed is quoted as follows:

> "Severe flooding damage occurs periodically at Tamaqua (population 12,000), at Reynolds, location of the Atlas Powder Company, and on several other reaches along the river, flooding damages start between a 5-and 10-year frequency of occurrence. The high stream gradient produces velocities capable of causing great damage even at bank-full stages to the Reading Railroad's main branch along the Little Schuylkill River."

Consistent with the "High" hazard potential classification of this structure, significantly more damage, including loss of life, would occur if the structure failed during passing of the PMF than if the dam did not fail during passing of the PMF. Therefore, the "High" hazard potential classification of this dam is justified.

SECTION 6
STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability.

a. Visual Observations. The visual observations indicated no evident embankment instability potential. The upstream and downstream riprap was stable and in quite good condition. Although the quality of the rock was assessed to be good, the nature of the shale rock lends itself to deterioration. However, this deterioration is expected to occur at a slow rate. There were no exterior signs or evidence indicating that internal drainage systems were operating improperly.

A careful inspection of the marshy areas located as shown on Sheet 5a of Appendix B reveal that these zones were topographic lows which temporarily retain run-off water. Inspection reports located in DER files further confirm that the topographic lows were created during the construction of the dam and during repair work to the discharge conduit.

The exposed portions of the principal spillway were inspected and judged to be in good condition. The pond drain valve was also in good condition. The emergency spillway was assessed to be in good condition, but sloughing of the emergency spillway should be expected during the lifetime of the impoundment.

b. Design and Construction Data. Design documentation was limited to several pages of data extracted from a report submitted by the design engineer, Berger Associates, Inc. The design engineers searched their files but could not find design hydrographs. Items such as structural calculations, stability analysis, flood routing data, and other calculations normally associated with the design of a reservoir and appurtenant facilities were also unavailable. The designer submitted a one-page summary of the stability analysis results, which indicates that the lowest factor of safety is 1.31 for normal operating conditions.

A summary of the construction material testing was provided by the design engineer. The values were reviewed and the basic soil parameters appear to be reasonable for the types of materials in this geologic area.

Inquiries were also made with the design engineer and park personnel, but construction data could not be located. Therefore, the only available construction data were the ten drawings in DER files labeled "Final Construction", as well as letters and memorandums. Supplemental construction data was also obtained from local residents that participated in the construction of the dam.

During the visual inspection, several checks were made of the dam features and compared with the design drawings. These checks agreed with the construction drawings. The specific field checks included the crest width, upstream and downstream slope inclinations, dimensions of the principal spillway, dimensions

of the principal spillway discharge pipe, emergency spillway dimensions, size of riprap, and overall dimensions of the plunge pool.

Since the stability calculations for this embankment were not available, the stability evaluation was limited to the summary of results provided by the designer and an assessment of the embankment section. This assessment indicates that the cross-section presented on Plate 3, Appendix E, appears reasonable. The slopes both upstream and downstream and the crest width are reasonable for an embankment composed of material native to the area and compacted to the specification requirements.

c. Operating Records. There are no operational records for this structure.

d. Post-Construction Changes. There are no reports nor is there any evidence that modifications were made to this dam other than the rehabilitation of the plunge pool and repair of the cracks in the principal spillway discharge pipe.

e. Seismic Stability. This dam is located in Seismic Zone 1. Normally it can be considered that if a dam in this zone is stable under static loading conditions, it can be assumed safe for any expected earthquake conditions. Since the static stability analysis results indicate a factor of safety of at least 1.31, the seismic stability of the dam is considered adequate.

SECTION 7
ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessments.

a. Evaluation. The visual inspection and review of the limited design and as-built documentation indicates that the dam, foundation and appurtenant structures of Tuscarora State Park Dam are in good condition. The hydrologic and hydraulic computations presented in Appendix C indicates that the dam will pass the probable maximum flood (PMF) without overtopping. Therefore, the spillway systems of this structure are considered to be "Adequate". It is noted that, although the structure has been designed to pass the PMF, flooding of the downstream bridge immediately upstream of the confluence with the Little Schuylkill River is likely. Significant property damage is also expected along the Little Schuylkill as a result of high flows from Tuscarora State Park Dam and other drainage basins upstream. It is expected that, in the event of failure, extreme property damage and possible loss of life could occur along the Little Schuylkill River and in the town of Tamaqua.

b. Adequacy of Information. The limited information available for this inspection was sufficiently adequate to evaluate the structure.

c. Urgency. It is recommended that the suggestions presented in Section 7.2 be implemented as soon as practical.

7.2 Remedial Measures.

a. Facilities. It is recommended that the following measures be undertaken. These recommendations are presented in order of priority, but does not infer that the latter recommendations are not important.

1. The plunge pool should be checked after each severe storm for movement of the rock or undermining under the discharge pipe.

2. The side slopes of the emergency spillway should be checked at least once per year and talus accumulations removed.

3. Woody vegetation should be removed annually from the downstream slope of the embankment and the emergency spillway.

4. An alternate means of gaining access to the dam during periods of flow over the emergency spillway should be established so the dam can be monitored.

b. Operation and Maintenance Procedures. Because of the location of the dam upstream from the highly populated area, Tamaqua, Pennsylvania, a formal

procedure of observation and warning during periods of high precipitation should be developed and implemented. This procedure should include a method of warning downstream residents and industries. It is noted that in the event that the emergency spillway is used, access to the dam for monitoring would be extremely limited. It is recommended that alternate means of access to the embankment be developed so that the structure can be monitored during these storms.

The Owner's operational procedure and maintenance procedure was reviewed and it is concluded that the procedure is comprehensive and sufficient for the operation and maintenance of this dam.

APPENDIX

A

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION
PHASE I

NAME OF DAM *Locust Creek Dam*

ID # *PA00699*

ITEM	REMARKS
AS-BUILT DRAWINGS	*A 10-page set of final construction drawings were available and essential features are reproduced in Appendix E.*
REGIONAL VICINITY MAP	*See Plate 1 of Appendix E, Delano Quadrangle.*
CONSTRUCTION HISTORY	*Several fairly detailed monthly construction reports were available from April 1963 through January 1964.*
TYPICAL SECTIONS OF DAM	*Yes. See Appendix E, Plate 3 for details.*
OUTLETS - PLAN	*See Appendix E.*
DETAILS	
CONSTRAINTS	*Yes. Data was obtained from the Park Office's maintenance and operation manual.*
DISCHARGE RATINGS	
RAINFALL/RESERVOIR RECORDS	*None.*

ITEM	REMARKS
DESIGN REPORTS	*There were no reports in DER files.*
GEOLOGY REPORTS	*There were no reports in DER files.*
DESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	*There were no reports in DER files.*
MATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	*Boring records are presented on the construction drawings.*
POST-CONSTRUCTION SURVEYS OF DAM	*None*
BORROW SOURCES	*The borrow source locations were delineated on the construction drawings and monthly reports confirmed their use.*

ITEM	REMARKS
MONITORING SYSTEMS	*None.*
MODIFICATIONS	*The Department of Environmental Resources issued Drawing No. R54:3-2.1, entitled "Grouting Outlet Conduit", dated 12/21/73, presented as Plate 9 of Appendix E. Repair work was performed to the conduit.*
HIGH POOL RECORDS	*None.*
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	*None. The only work performed was the rehabilitation of the outlet conduit under the direction of the Corps of Engineers.*
PRIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	*None.*
MAINTENANCE OPERATION RECORDS	*None, but, the park personnel and DER inspect the dam twice a year and yearly, respectively.*

ITEM	REMARKS
SPILLWAY PLAN SECTIONS DETAILS	*See Appendix E.*
OPERATING EQUIPMENT PLANS & DETAILS	*See Appendix E.*
MISCELLANEOUS DOCUMENTS	1. *"Report Upon the Application of the Department of Forests and Waters, Division of Flood Control", by DER, J.J. Ellam, June 1, 1962.* 2. *Monthly progress reports from the Division of Flood Control to DER, April 6, 1963 through January 1964.* 3. *Various inspection reports by the State Park and U.S. Department of Agriculture 1964 through 1977.* 4. *Construction Specifications by SCS, Northeast, 12-1-64.*

APPENDIX

B

CHECK LIST
VISUAL INSPECTION
PHASE I

Name Dam *Locust Creek Dam* County *Schuylkill* State *Pennsylvania* National ID # *PA00699*

Type of Dam *Rolled Earth* Hazard Category *I (High)*

Date(s) Inspection *1 August 1978* Weather *Cloudy, Humid* Temperature *70's*

Pool Elevation at Time of Inspection *1008.0* M.S.L. Tailwater at Time of Inspection *945.6* M.S.L.

Inspection Personnel:

Vince McKeever (Hydrologist) *John Boschuk, Jr. (Geotech/Civil)* *Brady Bisson (Geotechnical)*

Mary Beck (Hydrologist) *John Frederick, Jr. (Geotechnical)*

John Boschuk, Jr. Recorder

Remarks:

Additional representation on this inspection included:

Dennis Harris, Park Operator *Terry Killian, DER Reading Office*

Art Moeller, Park Superintendent

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ANY NOTICEABLE SEEPAGE	*N/A*	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	*N/A*	
DRAINS	*N/A*	
WATER PASSAGES	*N/A*	
FOUNDATION	*N/A*	

CONCRETE/MASONRY DAMS

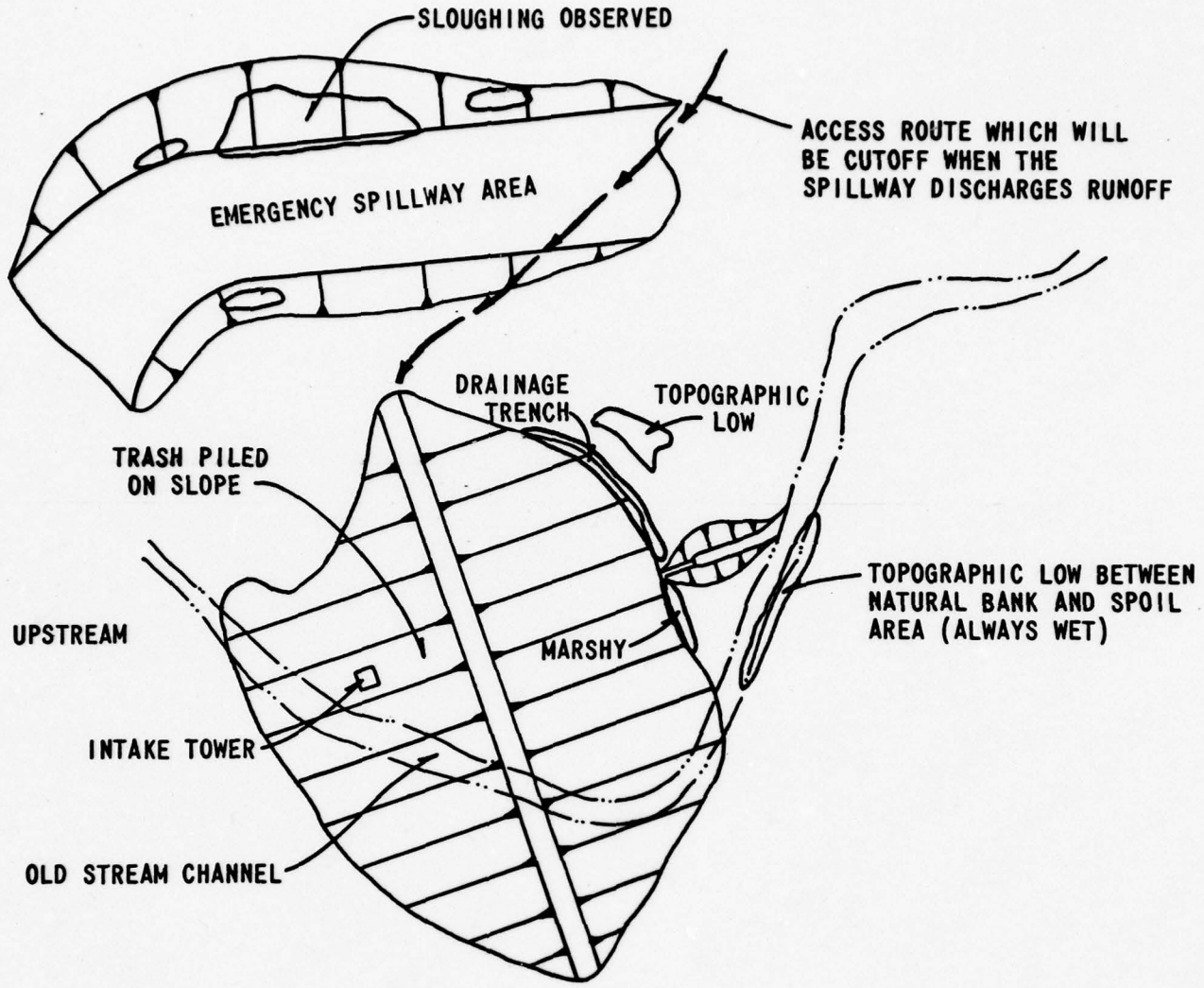
VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	*N/A*	
STRUCTURAL CRACKING	*N/A*	
VERTICAL AND HORIZONTAL ALIGNMENT	*N/A*	
MONOLITH JOINTS	*N/A*	
CONSTRUCTION JOINTS	*N/A*	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	*None observed.*	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	*None observed.*	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	*None observed.*	
VERTICAL AND HORIZONTAL ALIGNMENT OF THE CREST	*No movements observed.*	
RIPRAP FAILURES	*None observed.*	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	*The junctions of the dam with the abutment were observed to be in good condition.*	
ANY NOTICEABLE SEEPAGE	*See Sheet 5a. Cattails were noted along the toe of the dam right of the discharge plung pool. Other areas of standing water were observed as noted on the sketch.*	
STAFF GAGE AND RECORDER	*None*	
DRAINS	*Internal drains are buried in the embankment and could not be inspected.*	



SEEPAGE LOCATION PLAN AND NOTES FROM FIELD INSPECTION TUSCARORA STATE PARK DAM

SHEET 5a OF 11

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	*None observed.*	
INTAKE STRUCTURE	*The accessible portions of the structure were determined to be in good condition. The inspection team requested that the tower be drained to allow access inside the tower and discharge pipe, but the Park Superintendent stated that the Fish Commission must approve, and it would take 2 to 3 months to obtain the approval.*	
OUTLET STRUCTURE	*The pipe is in good condition.*	
OUTLET CHANNEL	*The plung pool was rehabilitated in 1973 by the Corps of Engineers and observed to be in good condition. There were no signs of significant displacement or erosion.*	
SLUICE GATE	*The pond drain sluice gate was exercised and the gate operated properly.*	

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	*None*	
APPROACH CHANNEL	*The emergency channel is excavated into the shale bedrock. See comments below.*	
DISCHARGE CHANNEL	*The emergency channel is excavated into the shale bedrock. See comments below. Approximately 420 feet downstream of the dam axis the emergency spillway falls away. It is noted that small trees have recently been cut immediately downstream of the fall-off.*	
BRIDGE AND PIERS	*N/A*	
COMMENTS	*The channel bottom is deteriorating and the shale is breaking down, but it is not a serious hazard and will not affect the ability of the spillway to pass flows. The side slopes are also deteriorating and talus is accumulating at the base of the slopes. This area is periodically cleaned and the Park personnel are aware of the problem. Woody vegetation is also periodically removed.*	

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	*N/A*	
APPROACH CHANNEL	*N/A*	
DISCHARGE CHANNEL	*N/A*	
BRIDGE AND PIERS	*N/A*	
GATES AND OPERATION EQUIPMENT	*N/A*	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	*None*	
OBSERVATION WELLS	*None*	
WEIRS	*None*	
PIEZOMETERS	*None*	
OTHER	*None*	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	*The reservoir side slopes are stable, moderate to steep and well vegetated with trees.*	
SEDIMENTATION	*There is no significant sedimentation in the reservoir.*	

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	*Approximately 3750 feet downstream of the dam, Locust Creek passes under State Route L.R. 53117 through a 30 by 16-foot bridge before entering Little Schuylkill River. The bridge should not obstruct large flows but debris would probably destroy the bridge in the event of dam failure.*	
SLOPES	*The valley gradient is approximately 0.6 percent. The bottom of the stream is stoney.*	
APPROXIMATE NO. OF HOMES AND POPULATION	*The major damage center is Tamaqua (population 12,000), approximately 2.5 miles below the confluence of Locust Creek and Little Schuylkill River.*	

APPENDIX
C

(LOCUST CREEK DAM)
TUSCARORA STATE PARK DAM
CHECK LIST
HYDROLOGIC AND HYDRAULIC
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: *Long, narrow watershed, about 50 percent wooded, little residential development.*

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): *1007.5 (1965 Acre-Feet)*

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): *1043.5 (7000 Acre-Feet est.)*

ELEVATION MAXIMUM DESIGN POOL: *1036.4 (6000 Acre-Feet)*

ELEVATION TOP DAM: *1043.5*

EMERGENCY SPILLWAY

a. Elevation *1029.0*

b. Type *Trapezodial channel cut through rock.*

c. Width *150 feet.*

d. Length *750 feet.*

e. Location Spillover *Left abutment.*

f. Number and Type of Gates *None.*

PRINCIPAL SPILLWAY

a. Type *A Soil Conservation Service type riser with an attached access chamber.*

b. Location *300 feet from left abutment.*

c. Entrance inverts *1007.5*

d. Exit inverts *947.1*

e. Emergency draindown facilities *24 inch pond drain, entrance invert 953.4*

HYDROMETEOROLOGICAL GAGES:

a. Type *None.*

b. Location

c. Records

MAXIMUM NON-DAMAGING DISCHARGE: *5400 cfs - approximate capacity of first downstream bridge.*

DAM SAFETY ANALYSIS
HYDROLOGIC/HYDRAULIC DATA

Date: 8/21/78
By: MEB
Sheet: 2 of 11

Tuscarora State Park Dam
DAM (Locust Creek Dam) Nat. ID No. PA00699 DER No. 54-170

	ITEM/UNITS	Permit/Design Files (A)	Calc. from Files/Other (B)	Calc. from Observations (C)
1.	Min. Crest Elev., ft.	1043.5		
2.	Freeboard, ft.	5.0		
3.	Spillway(1) Crest Elev, ft.	1007.5		
3a.	Secondary(2) Crest Elev, ft.	1029.0		
4.	Max. Pool Elev., ft.	1037.7		
5.	Max. Outflow(3), cfs			
6.	Drainage Area, mi^2	13.1		13.0
7.	Max. Inflow(4), cfs			
8.	Reservoir Surf. Area, Acre	96.1		92.5
9.	Flood Storage(5), Acre-Feet	2675		
10.	Inflow Volume, Acre-Feet			

Reference all figures by number or calculation on attached sheets:

Example: 3A - Drawing No. xxx by J. Doe, Engr., in State File No. yyyy.

NOTES:

(1) Main emergency spillway.

(2) Secondary ungated spillway.

(3) At maximum pool, with freeboard, ungated spillways only.

(4) For columns B, C, use PMF.

(5) Between lowest ungated spillway and maximum pool.

Date: 8/21/78
By: MFB
Sheet: 3 of 11

HYDROLOGIC/HYDRAULIC CALCULATIONS (cont.)

Item (from Sheet 2)	Source
1A, 3A, 3aA, 6A, 8A, 9A	final construction drawings prepared by Berger Associates.
2A, 4A	Application Report dated June 1, 1962
6C, 8C	USGS Maps Delano, Pa (1969) Shenendoah (1969)

Classification (Ref.- Recommended Guidelines for Safety Inspection of Dams)

1. The hazard potential is rated as "high" as there would be loss of life if the dam failed.

2. The size classification is "INTERMEDIATE" based on its 98-foot height and normal storage of 1965 Ac-Ft.

3. The spillway design flood, based on size and hazard classification, is the probable maximum flood (PMF).

Hydrologic and Hydraulic Analysis

1. Original Data

No complete hydrologic / hydraulic design package was available for review. Information was supplied by the designer, Berger Associates, Inc. (but not the hydrographs or flood routings), the Soil Conservation Service (a preliminary flood routing), Tuscarora State Park Superintendent (spillway rating curves and capacity - area - elevation curves for both Tuscarora State Park Dam and the upstream Locust Lake Dam) and Bannett Fleming Corddry & Carpenter, Inc. (information on the upstream Locust Lake Dam).

The original design concluded that the upstream dams, Codorus Creek and Locust Lake Dam, did not control enough of the drainage area to influence the design considerations for the proposed Tuscarora State Park Dam.

2. Evaluation

Neglecting Locust Lake Dam is conservative if it is capable of discharging the PMF without failure. Information supplied by Bannett Fleming Corddry & Carpenter, Inc. indicates Locust Lake Dam can discharge the PMF without overtopping.

The preliminary flood routing from SCS indicates a peak PMF inflow of 33,200 cfs and a peak outflow of 28,000 cfs (see Sheet 7) This outflow

resulted from a 48 hr. storm with 29.73 inches of rainfall and 22.62 inches of runoff.

The first 6 hr of rainfall = 23.95 inches (sheet 7)
" " 6 hr. " runoff = 20.30 inches

From Weather Bureau TP-40, PMP = 25.3 inches for 6 hr - 10 sq mile storm. Assuming 90% runoff, runoff = 22.77 inches

Therefore, PMP may be somewhat low.

Peak PMF Inflow

Information from Corps of Engineers, Balt. District indicated comparision of Locust Creek with West Branch of Schuylkill, D.A. = 48 sq miles, estimated peak PMF inflow = 7200 cfs

Peak inflow for Locust Creek

$$\left(\frac{13.1}{4.8}\right)^{0.8} 7200 = 16,075 \text{ cfs}$$

Therefore, the peak PMF inflow shown on hydrograph is not unconservative and will be used.

Peak PMF Inflow = 33,200 cfs

Routed peak PMF outflow = 28,000 cfs

Check on emergency spillway capacity = 27,600 cfs with reservoir at 1043.5 ft., top of dam

Bottom width = 150 ft side slope varies from 1:1 to 2:1 (H:V) Length = 377 ft (from final construction drawings)

$d_c \sim 9.7$ ft (Soil Conservation Service
$H_{ec} \sim 14$ ft TR-39, ES-174)

Friction Head Loss, $h_f = 0.94$ ft
(S.C.S. TR-39, ES-176)

$H_p = H_{ec} + h_f = 14.94$ ft ~ 14.5 ft = (1043.5 - 1029)

Therefore, the rating curve is adequate.

Check on Flood Routing (see sheets 10 & 11)

Volume of inflow, V_I, =

$\frac{20.3}{12} \cdot 13.1 \cdot 640 \simeq 14,190$ Ac-Ft.

Q_I = Peak PMF Inflow = 33,200 cfs

Q_o = Max. outflow = 28,000

V_S = available flood storage = 7000 Ac-Ft to top of dam - extrapolated from sheet 9

V_R = required storage =

$$\left(1 - \frac{Q_o}{Q_I}\right) V_I$$

$$\left(1 - \frac{28,000}{33200}\right) 14,190 = 2222 \text{ Ac-Ft} < 7000$$

Therefore, flood routing is adequate and spillway is "Adequate"

Downstream Condition

Bridge opening under L.R. 53097 is about 16 x 30 ft with about 3 ft. between bottom of bridge and roadway.

Flow thru bridge estimated by orfice equation

$Q = CA\sqrt{2gH}$ Ref. National Engineering Handbook, Section 4, Eq 14-25

C ranges from 0.7 to 0.9; use 0.8

A = area of bridge opening

H = the difference in water surface elevation between headwater and tailwater. As bridge is about 200 ft. above Little Schuylkill River, assume that flow thru the bridge is backup by high water in the Little Schuylkill River so that H = 3 ft.

$Q = 0.8 \cdot 16 \cdot 30\sqrt{2g\,3} \simeq 5400$ cfs, a minimum value

BY MFB DATE 9/12/78 SUBJECT Tuscarora State Park Hydrology / Hydraulics SHEET 6a OF 11

CHKD. BY DATE JOB No

An estimate of bridge capacity by normal flow equation (Manning's)

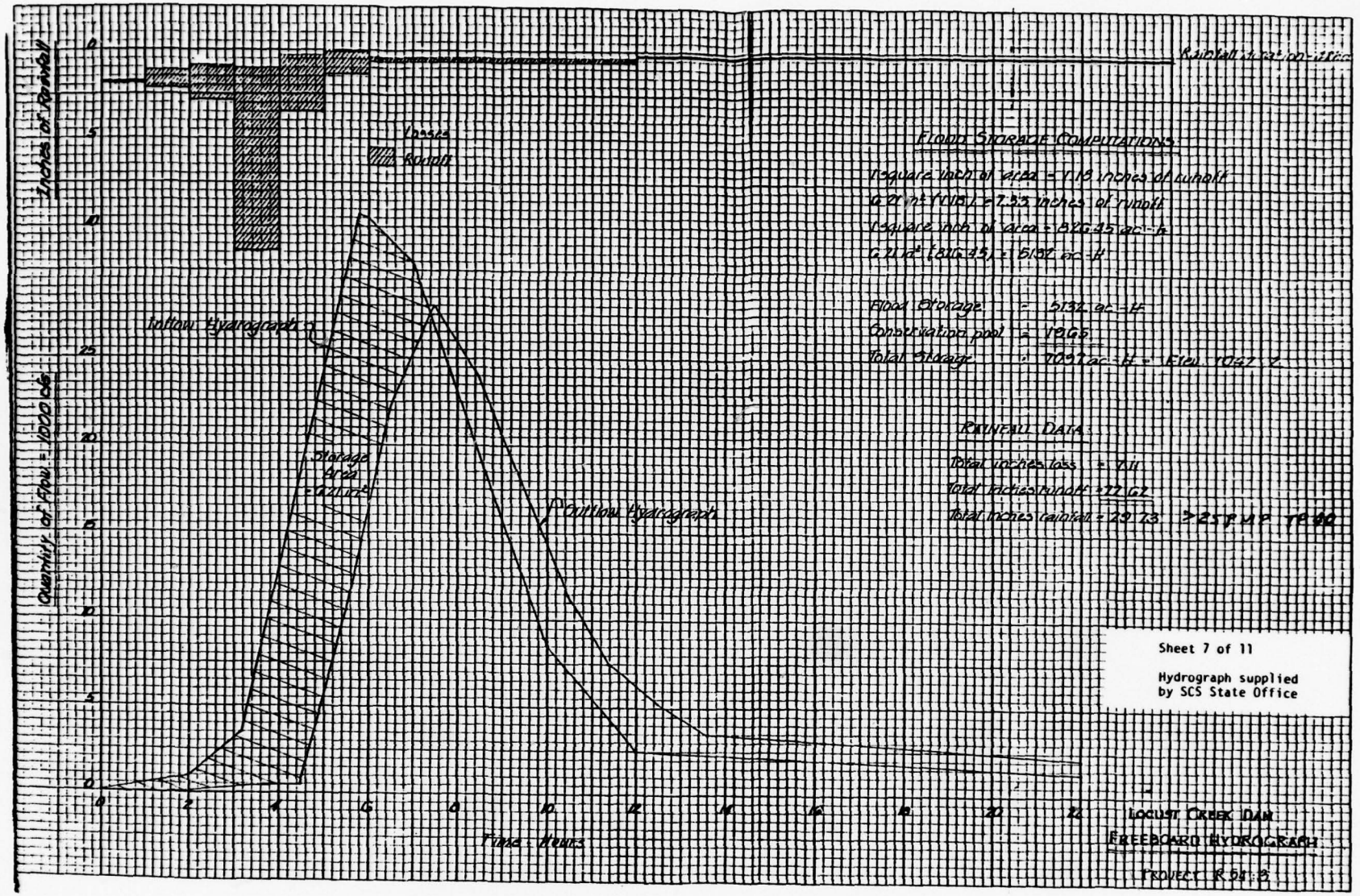
$$Q = 16.30 \cdot \frac{1.486}{0.025} \left(\frac{16.30}{30+2\cdot16}\right)^{2/3} 0.0066^{1/2}$$

$n = 0.025$ field estimated

$s = 0.0066$ - from USGS map

$Q \approx 9120$ cfs

Therefore, capacity of bridge depends on water surface elevation in the Little Schuylkill River



Flood Storage Computations

1 square inch of area = 1.18 inches of runoff

1.27 in² (1.18) = 1.53 inches of runoff

1 square inch of area = 826.45 ac-ft

6.21 in² (826.45) = 5132 ac-ft

Flood Storage = 5132 ac-ft

Conservation pool = 1965

Total Storage = 7097 ac-ft = Elev 1047.2

Rainfall Data

Total inches loss = 7.11

Total inches runoff = 22.62

Total inches rainfall = 29.73 7.25 P.M.P. TP-40

Sheet 7 of 11

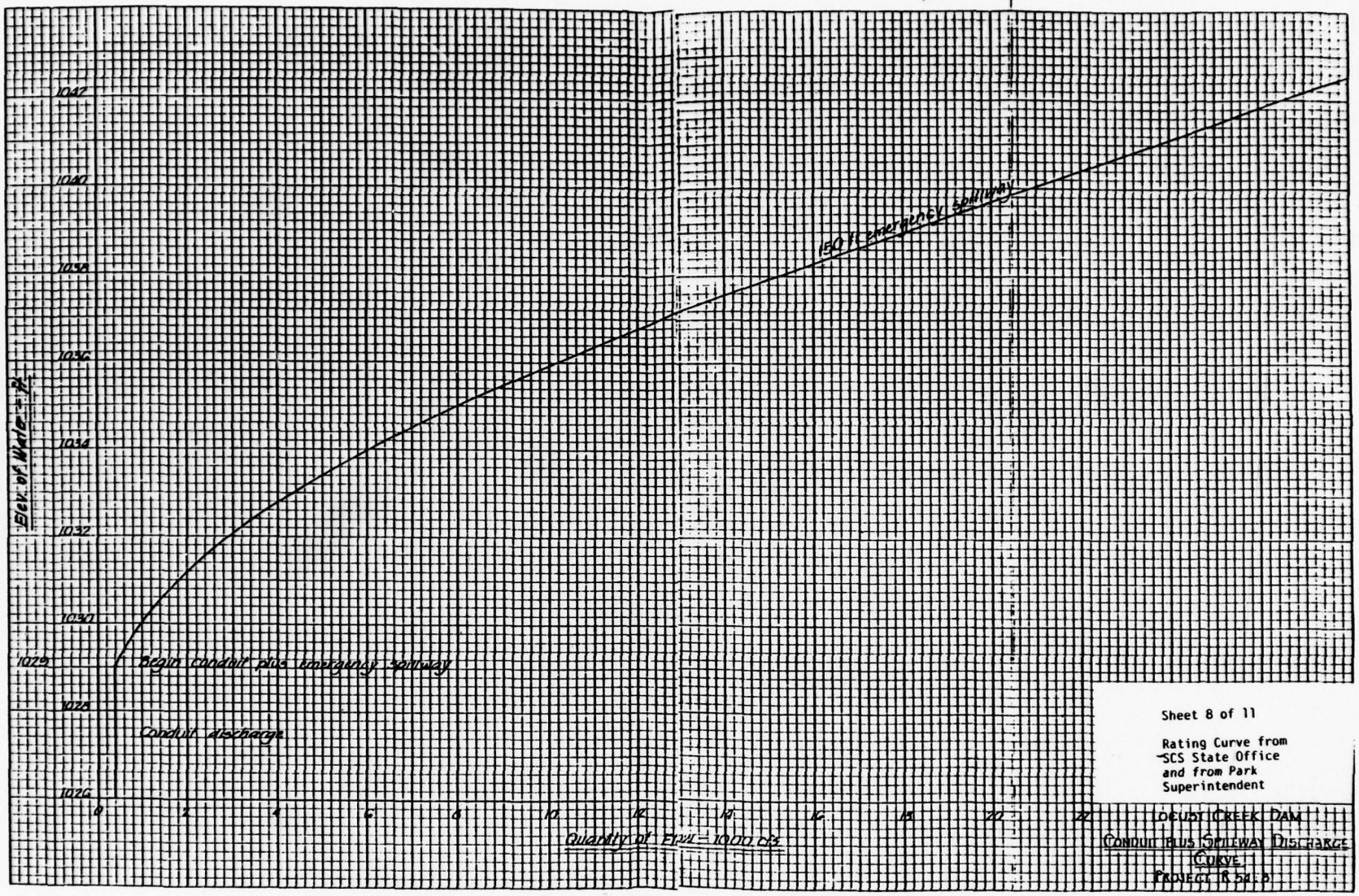
Hydrograph supplied by SCS State Office

LOCUST CREEK DAM

FREEBOARD HYDROGRAPH

PROJECT K-64-3

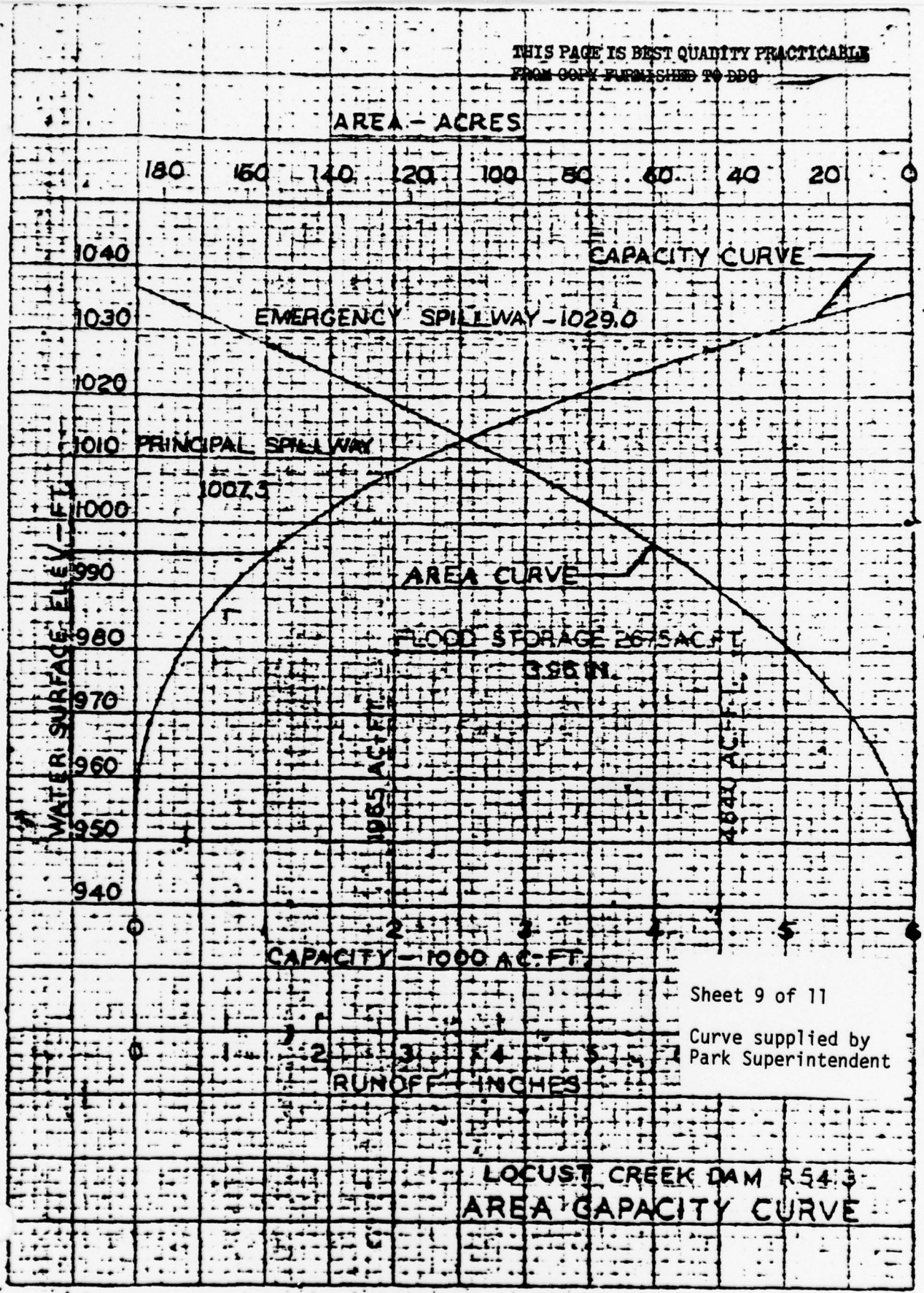
Plate 11



Sheet 8 of 11

Rating Curve from SCS State Office and from Park Superintendent

LOCUST CREEK DAM
CONDUIT PLUS SPILLWAY DISCHARGE CURVE
PROJECT IR 52-5

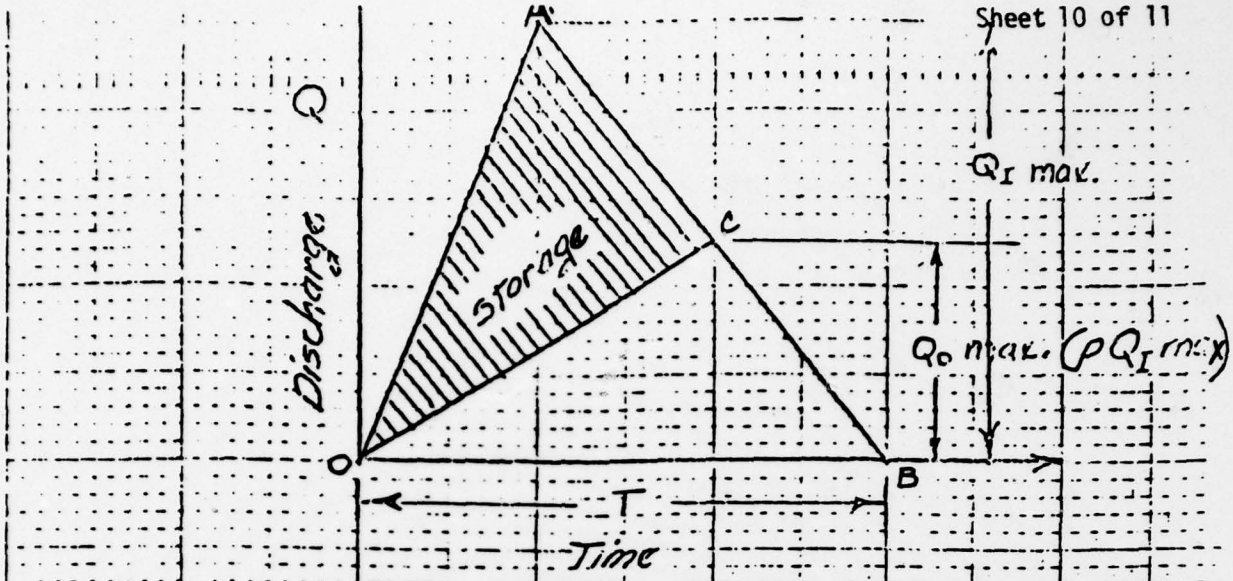


Sheet 9 of 11

Curve supplied by
Park Superintendent

LOCUST CREEK DAM R543
AREA CAPACITY CURVE

PLATE



PURPOSE: Establish relationship between maximum spillway discharge and storage required to pass flood hydrograph without exceeding maximum pool level.

$$\frac{\Delta AOC}{\Delta AOB} = \frac{\Delta AOB - \Delta COB}{\Delta AOB} = 1 - \frac{\Delta COB}{\Delta AOB}$$

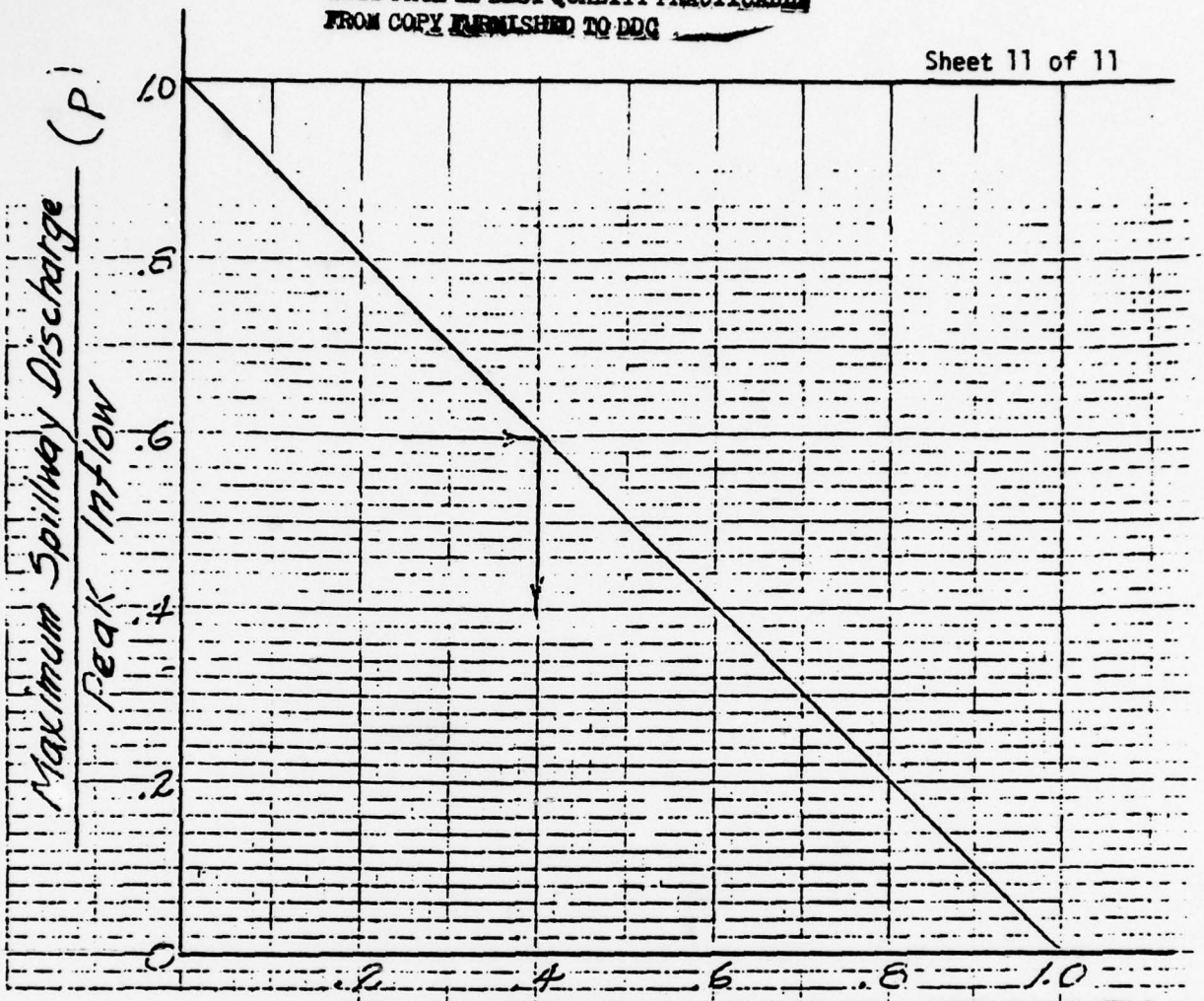
$$\frac{\Delta AOC}{\Delta AOB} = 1 - \frac{T \rho Q_I \text{ max}/2}{T\ Q_I \text{ max}/2} = 1 - \rho$$

$$\Delta AOC = (1-\rho)\,\Delta AOB \quad \text{where } 0 \le \rho \le 1.0$$

ρ	ΔAOC
1.00	0
0.75	0.25 ΔAOB
0.50	0.50 ΔAOB
0.25	0.75 ΔAOB
0	1.00 ΔAOB

REFERENCE

PRELIMINARY ENGINEER TECHNICAL LETTER NO. 1110-2- 25 January 1978

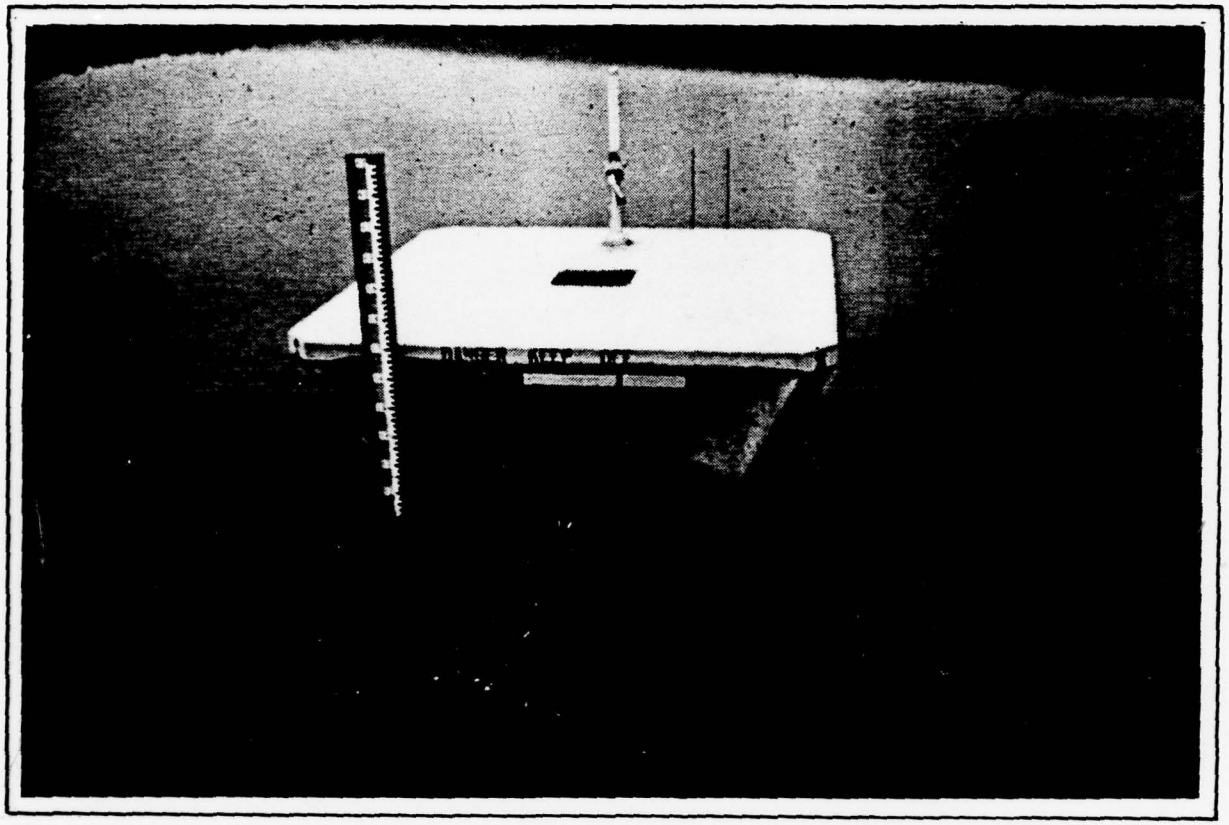


Steps to obtain required reservoir to pass inflow hydrograph without overtopping dam.

1. Obtain maximum spillway discharge
2. Develop inflow hydrograph
3. Compute relationship of maximum spillway capacity to peak inflow
4. Read relationship of required reservoir storage to volume of inflow hydrograph from curve

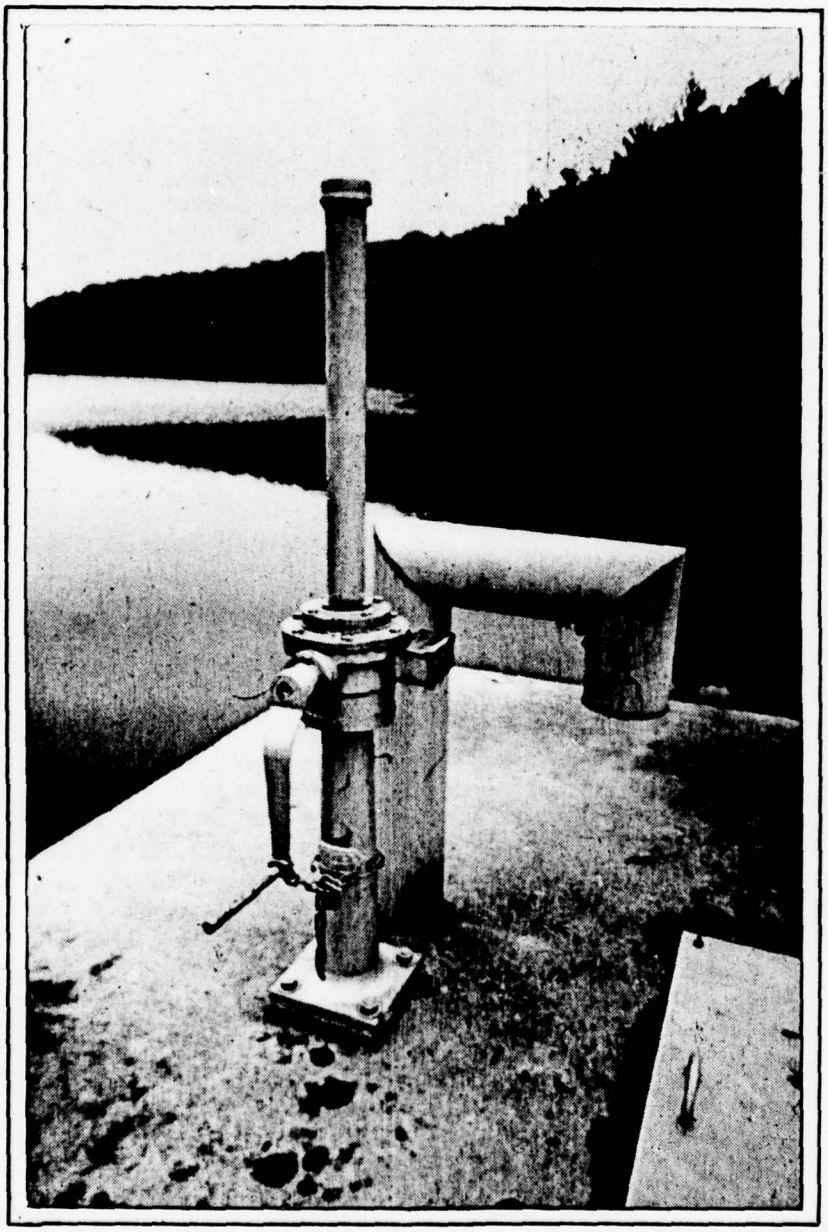
APPENDIX

D



PINCIPAL SPILLWAY. NOTE POND
DRAIN VALVE AND STAFF GAGE.

PHOTOGRAPH NO. 1

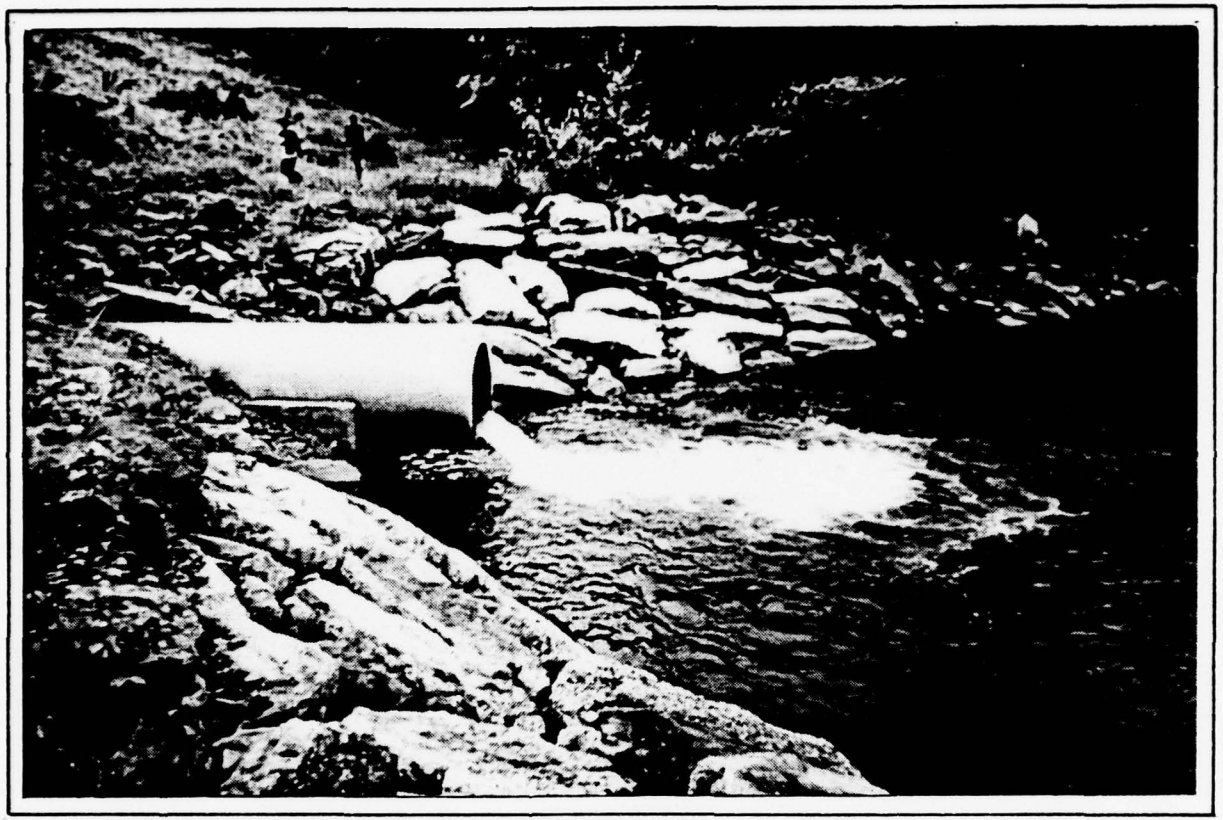


CLOSEUP VIEW OF POND DRAIN
AND AIR VENT.

PHOTOGRAPH NO. 2

VIEW FROM CREST LOOKING AT
PRINCIPAL SPILLWAY OUTLET
PIPE AND STILLING BASIN.

PHOTOGRAPH NO. 3

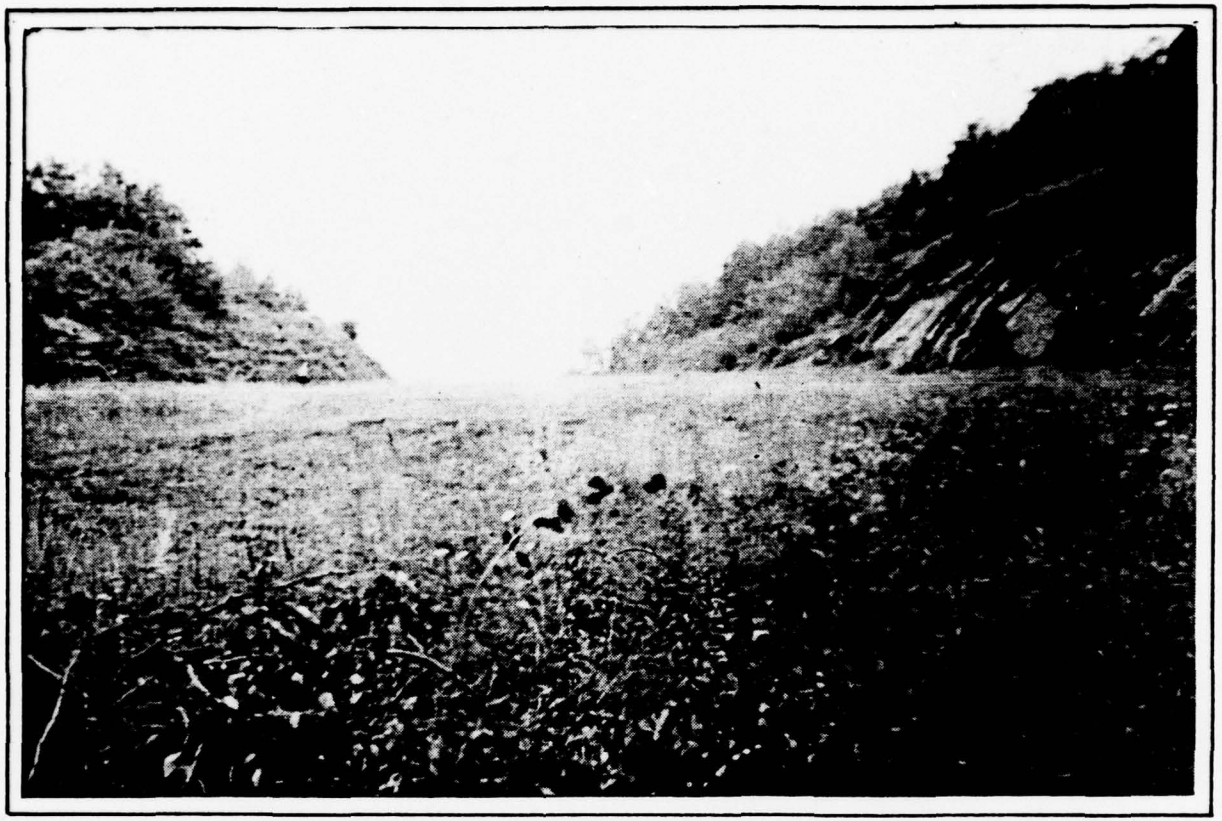


PRINCIPAL SPILLWAY DISCHARGE
PIPE.

PHOTOGRAPH NO. 4

VIEW OF DOWNSTREAM CHANNEL
BELOW PRINCIPAL SPILLWAY
STILLING BASIN.

PHOTOGRAPH NO. 5



EMERGENCY SPILLWAY LOOKING
UPSTREAM.

PHOTOGRAPH NO. 6

VIEW OF LEFT ABUTMENT FROM
RIGHT ABUTMENT OF EMERGENCY
SPILLWAY. VIEW SHOWS AREA
WHICH HAS EXPERIENCED SLOPE
SLIDES IN THE PAST.

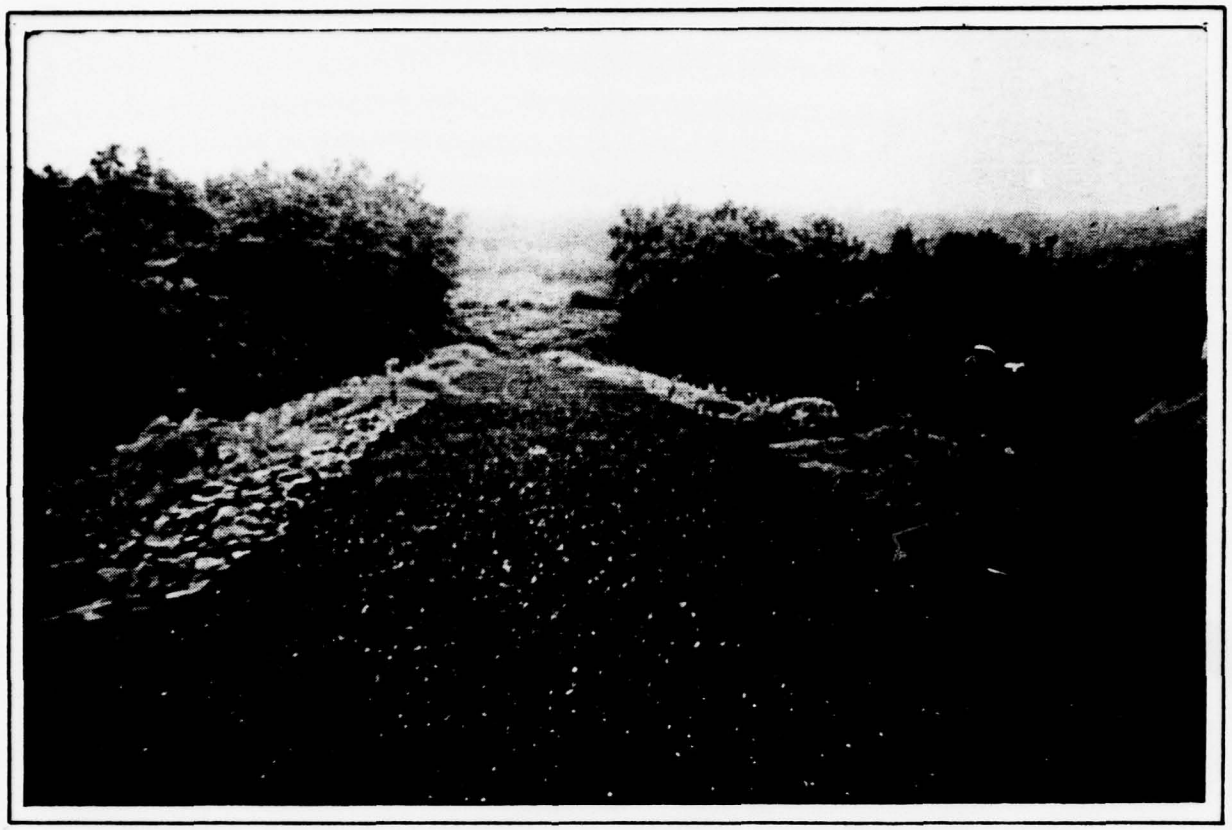
PHOTOGRAPH NO. 7

VIEW OF DOWNSTREAM END OF THE
EMERGENCY SPILLWAY.

PHOTOGRAPH NO. 8

UPSTREAM RIPRAP SLOPE RIGHT
OF PRINCIPAL SPILLWAY.

PHOTOGRAPH NO. 9



CREST OF DAM WITH CINDER
SURFACE LOOKING TOWARDS
LEFT ABUTMENT.

PHOTOGRAPH NO. 10

DOWNSTREAM SLOPE LOOKING
TOWARDS RIGHT ABUTMENT.

PHOTOGRAPH NO. 11

DEBRIS DEPOSITED ON SLOPE ABOVE PRINCIPAL SPILLWAY AFTER IT WAS REMOVED FROM THE TRASH RACKS. WOOD IS PERIODICALLY COLLECTED AND BURNED.

PHOTOGRAPH NO. 12

SEEPAGE AT DOWNSTREAM TOE
TO THE RIGHT OF THE OUTLET
PIPE. SEE SHEET 5a OF
APPENDIX B. CATTAILS
DELINEATE AREA.

PHOTOGRAPH NO. 13

SEEPAGE WATER AT DOWNSTREAM
TOE RIGHT OF OUTLET PIPE.

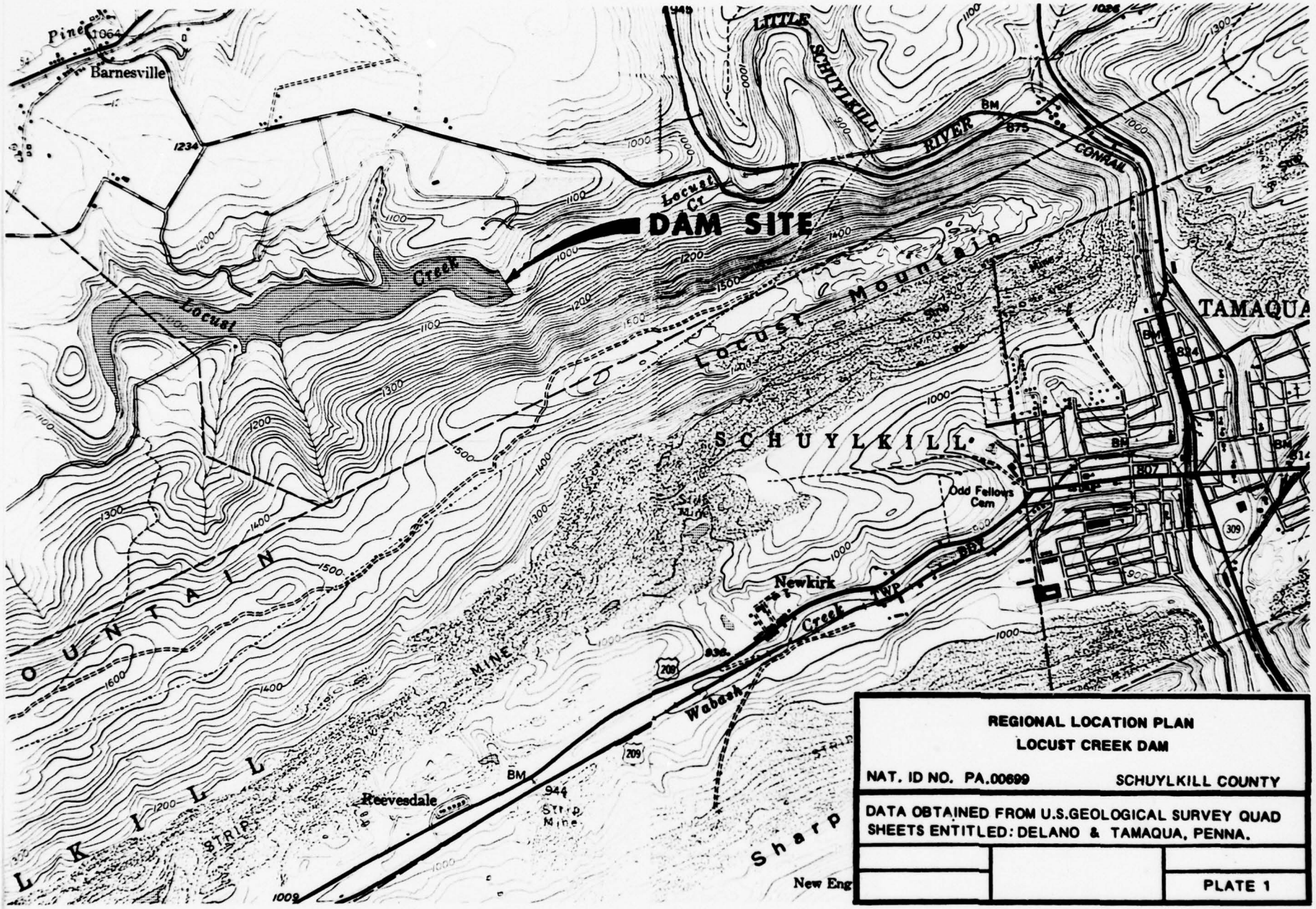
PHOTOGRAPH NO. 14

VIEW OF ONLY BRIDGE DOWNSTREAM
OF DAM.

PHOTOGRAPH NO. 15

APPENDIX

E

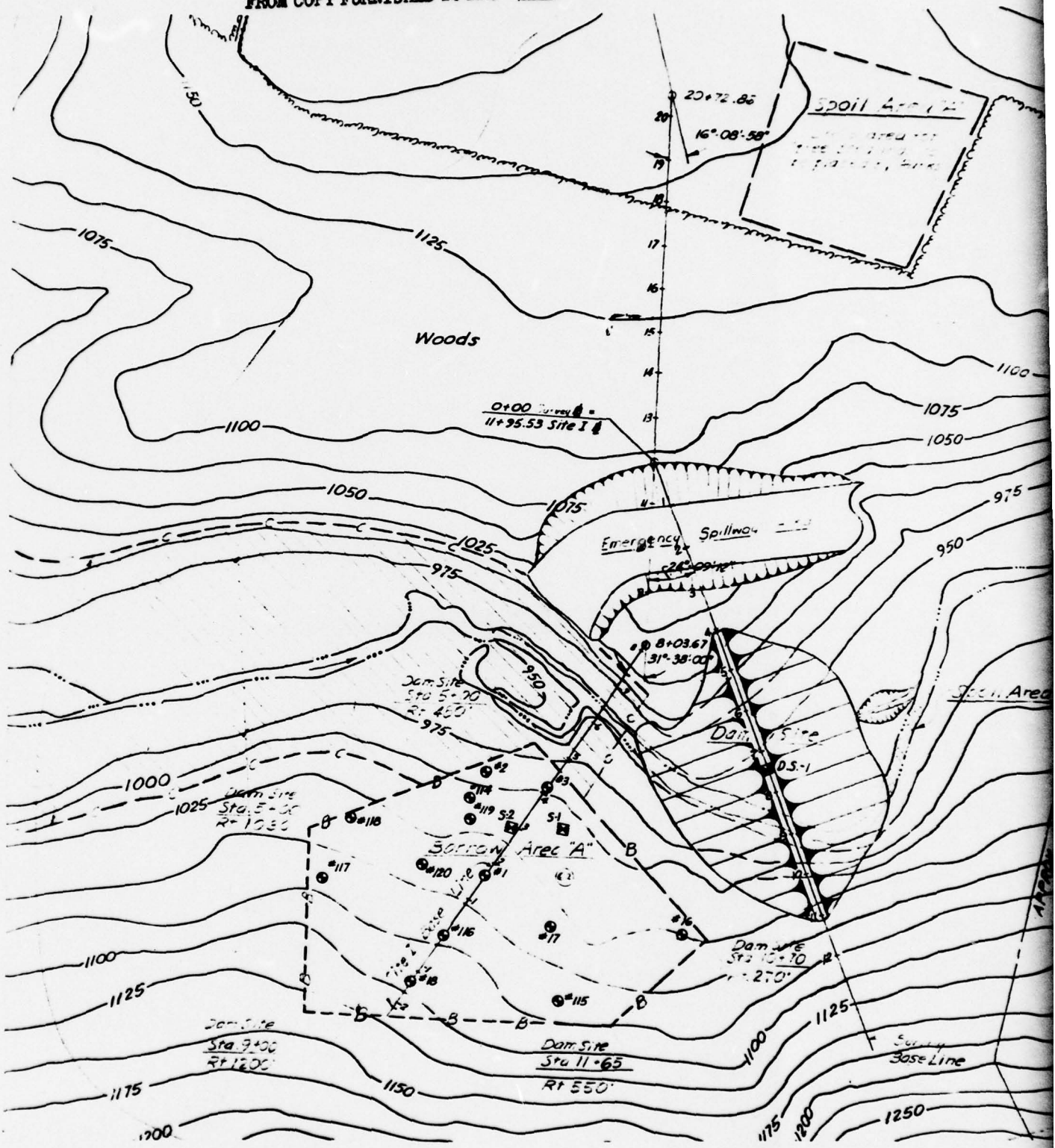


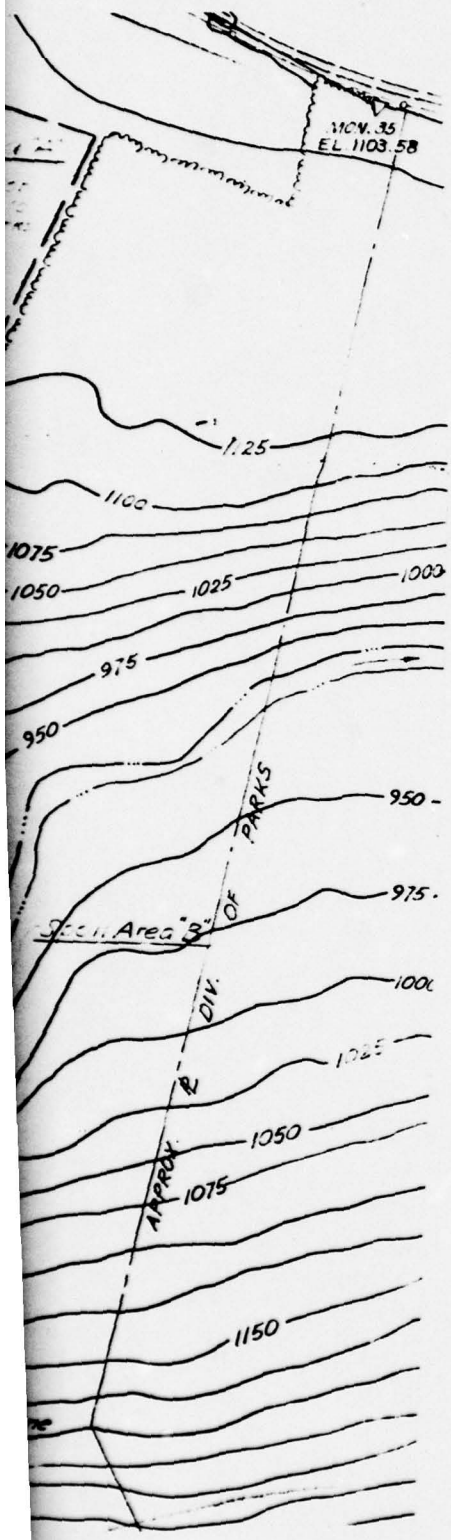
REGIONAL LOCATION PLAN
LOCUST CREEK DAM

NAT. ID NO. PA.00699 SCHUYLKILL COUNTY

DATA OBTAINED FROM U.S.GEOLOGICAL SURVEY QUAD SHEETS ENTITLED: DELANO & TAMAQUA, PENNA.

PLATE 1





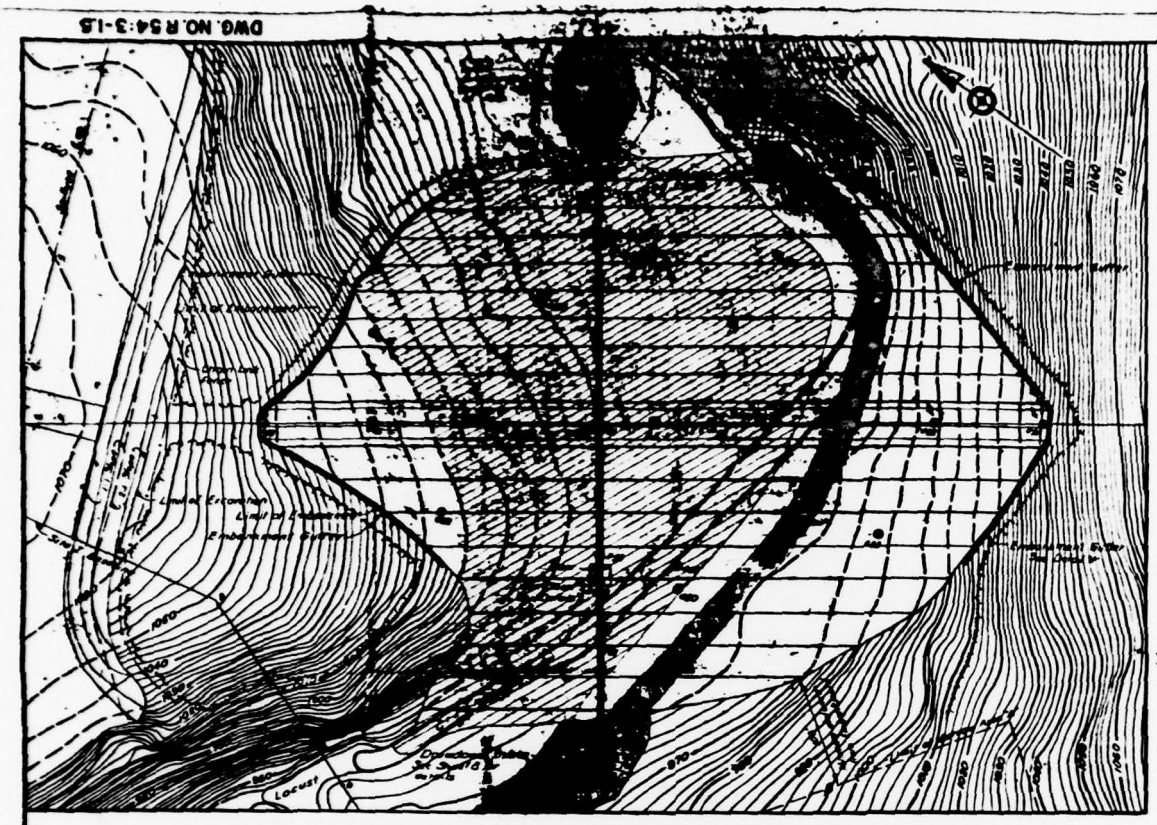
PLAN OF DAM AND APPURTENANCES
LOCUST CREEK DAM

NAT. ID NO. PA.00699 **SCHUYLKILL COUNTY**

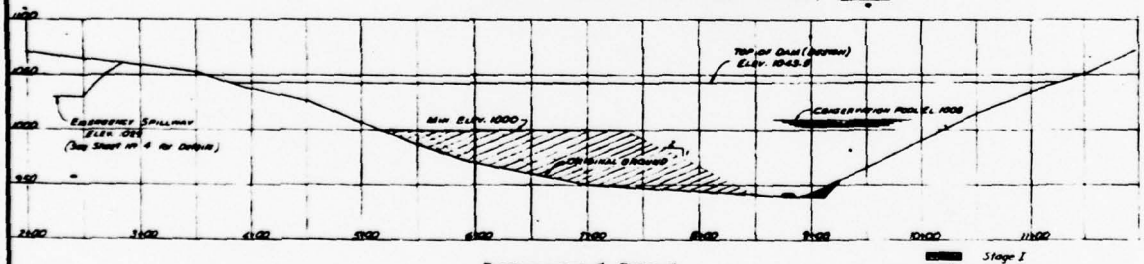
DATA OBTAINED FROM U.S. DEPT. OF AGRICULTURE, SOIL CONSERVATION SERVICE, DWG. NO. R54:3–1.2 , SHEET 2 OF 10

2

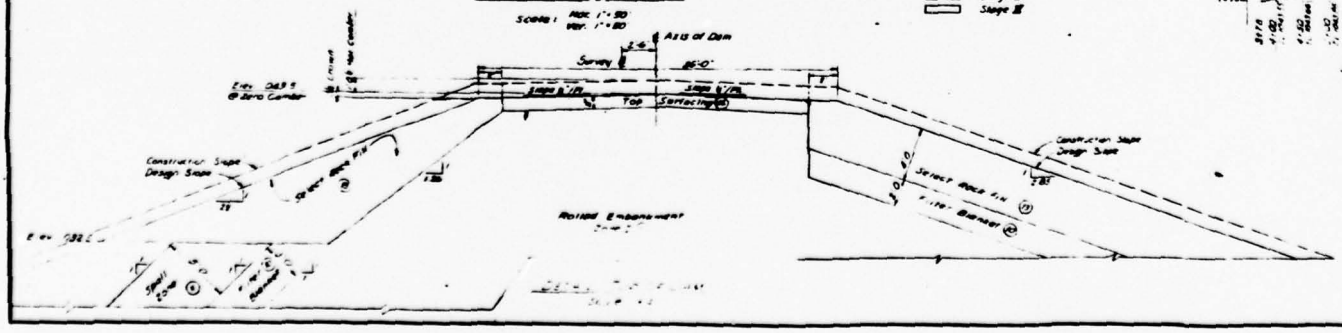
PLATE 2

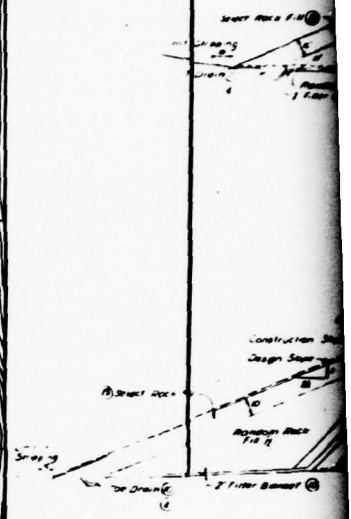


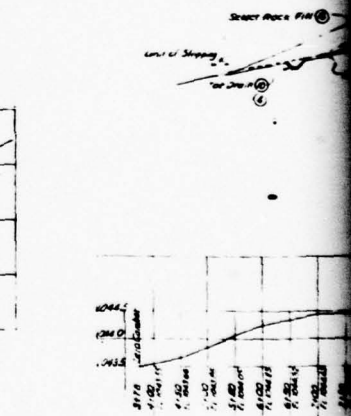
PLAN
Scale 1"=50'



EMBANKMENT & PROFILE
Scale: Hor. 1"=50
Ver. 1"=50



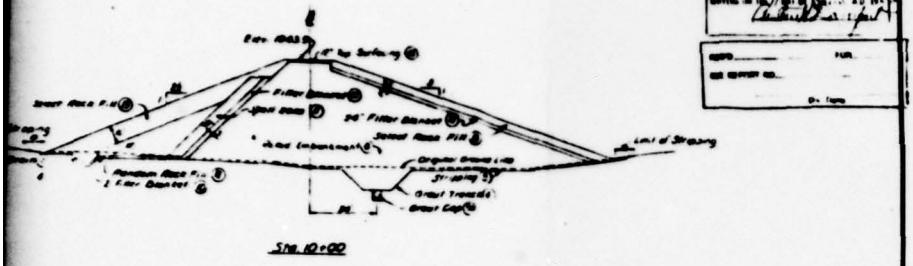




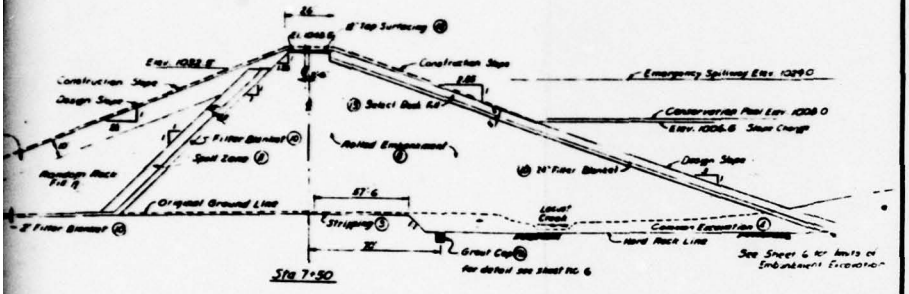
Stations Along Dam

CAMBER AT

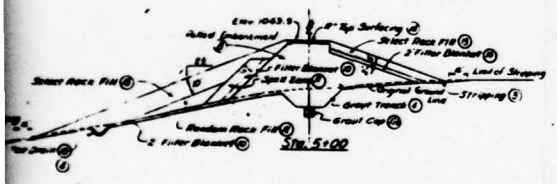
Scale:



Sta. 10+00



Sta. 7+50

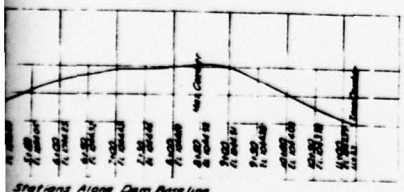


Sta. 5+00

EMBANKMENT SECTIONS
Scale 1"=30'

DETAIL "A"
EMBANKMENT GUTTER
Scale 1"=5'

NOTES:
Spoil Area "B" to be filled to Elev 950 or as directed by the Engineer.
See Sheet No 6 for Subsurface Details



Stations Along Dam Baseline

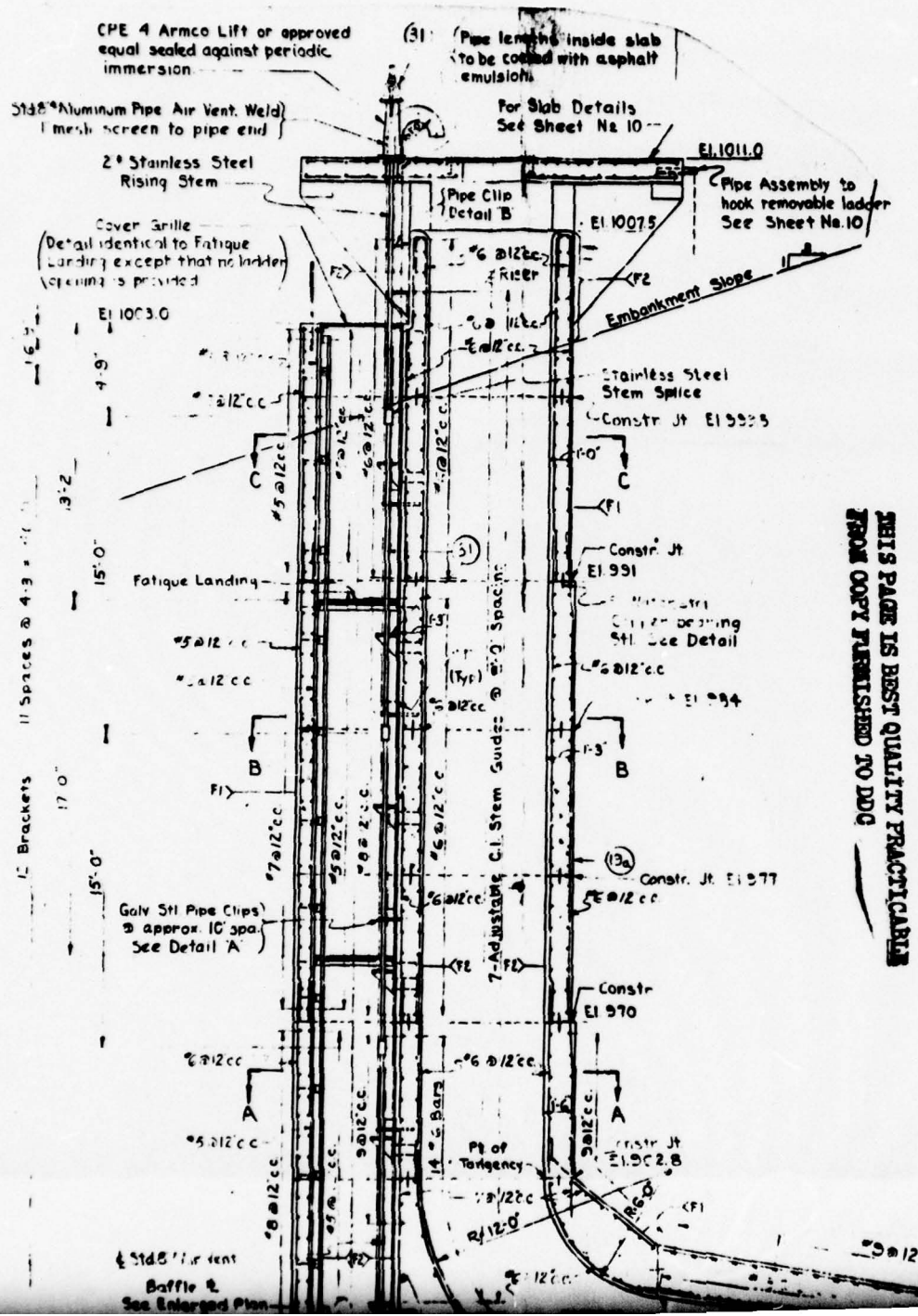
CAMBER AT TOP OF DAM
Scale: Hor. 1"=200'
Ver. 1"=1'

TYPICAL EMBANKMENT SECTION
LOCUST CREEK DAM

NAT. ID NO. PA.00699 **SCHUYLKILL COUNTY**

DATA OBTAINED FROM U.S. DEPT. OF AGRICULTURE, SOIL CONSERVATION SERVICE, DWG. NO. R54:3–1.5 , SHEET 5 OF 10

PLATE 3



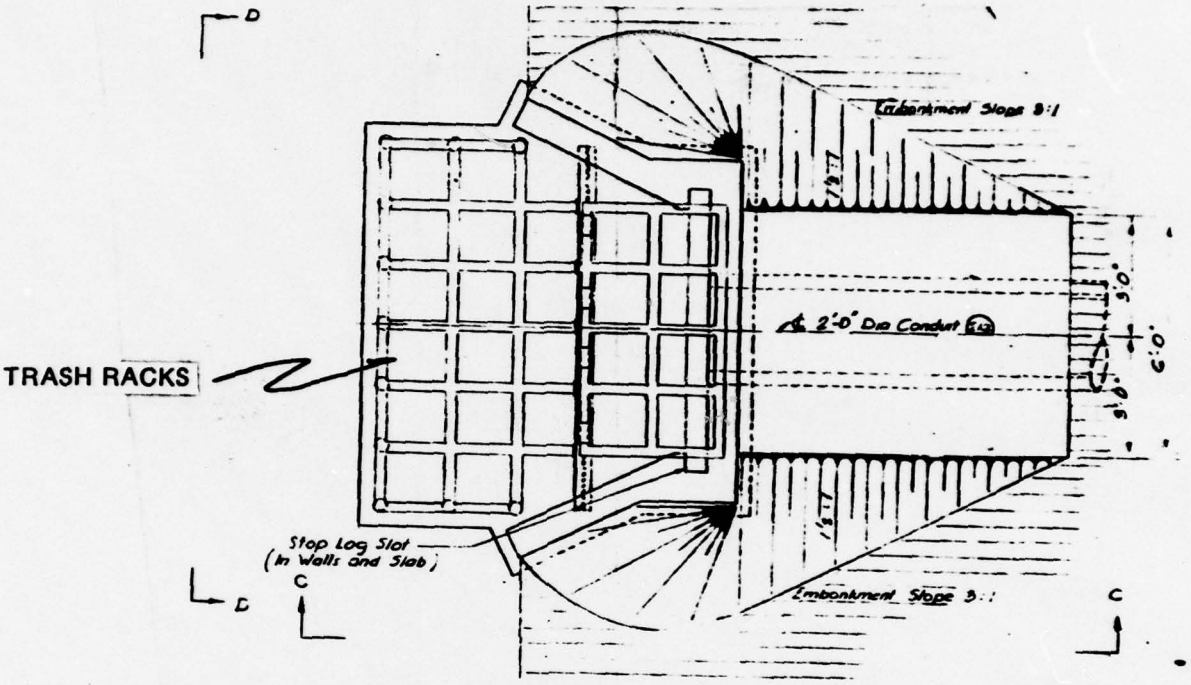
RISER DETAILS

LOCUST CREEK DAM

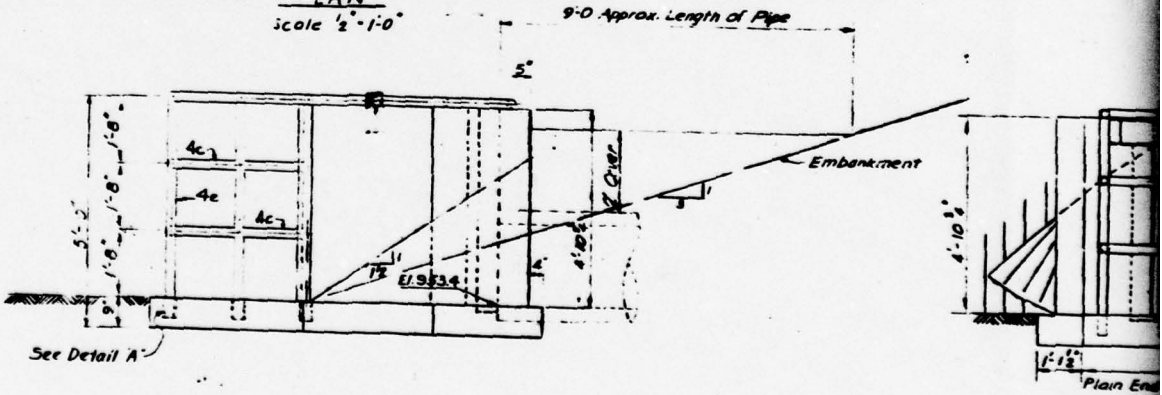
NAT. ID NO. PA.00699 **SCHUYLKILL COUNTY**

DATA OBTAINED FROM U.S. DEPT. OF AGRICULTURE, SOIL CONSERVATION SERVICE, DWG. NO. R54:3–1. 9 , SHEET 9 OF 10

PLATE 4

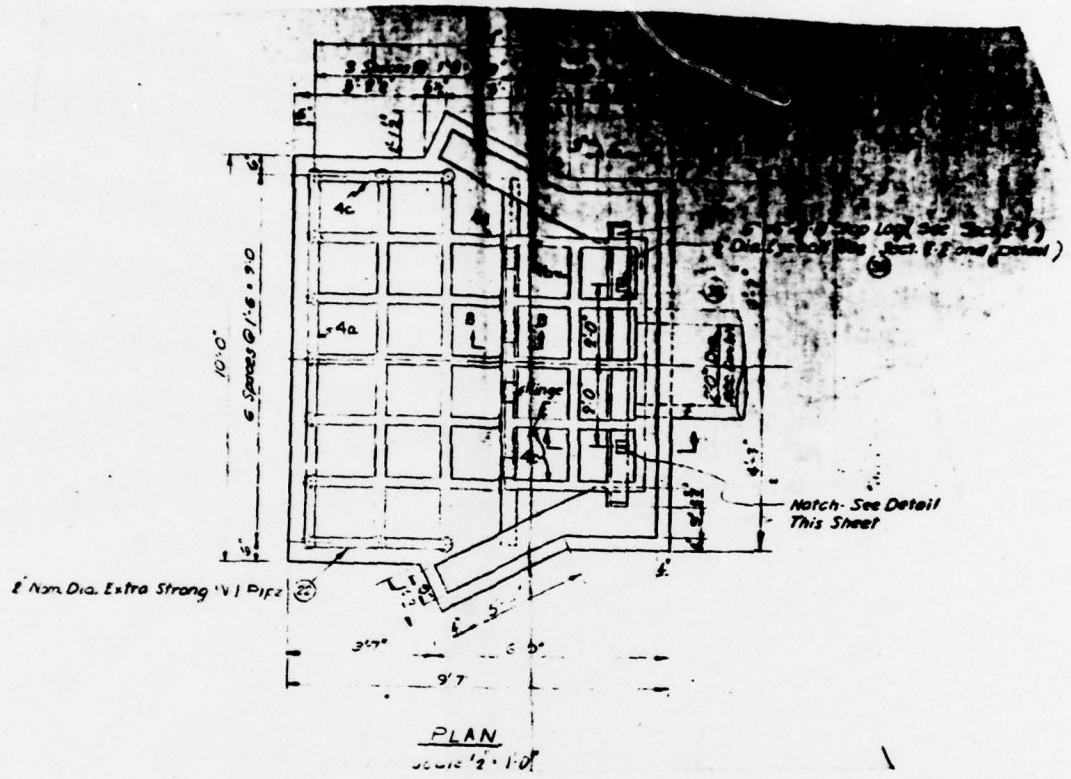


PLAN
Scale 1/2"-1'-0"

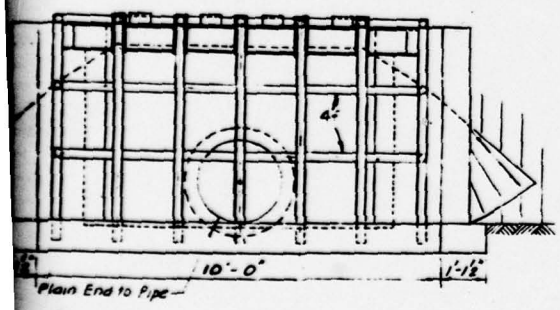


ELEVATION C-C
Scale 1/2"-1'-0"

INTAKE STRUCTURE



PLAN

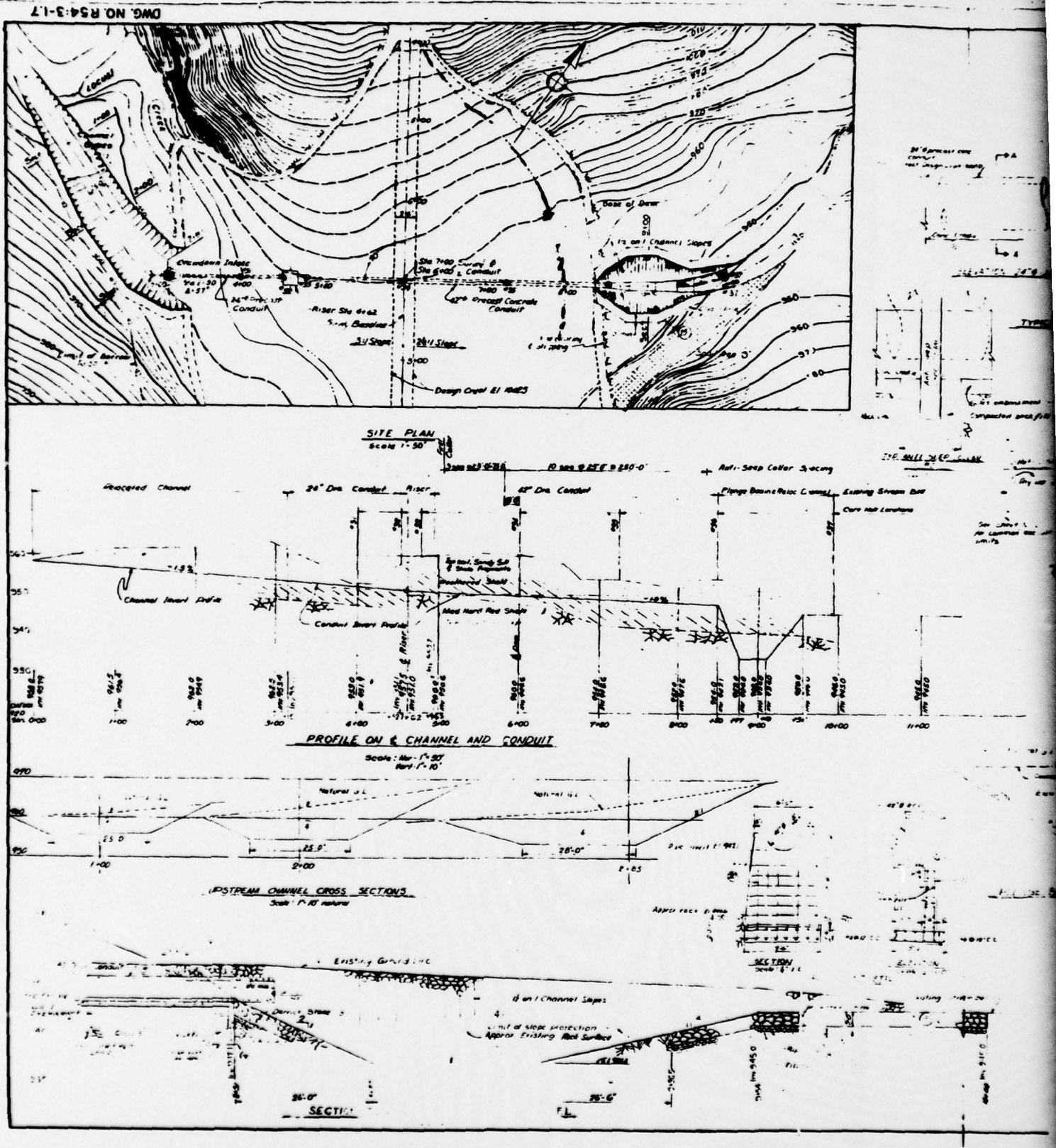


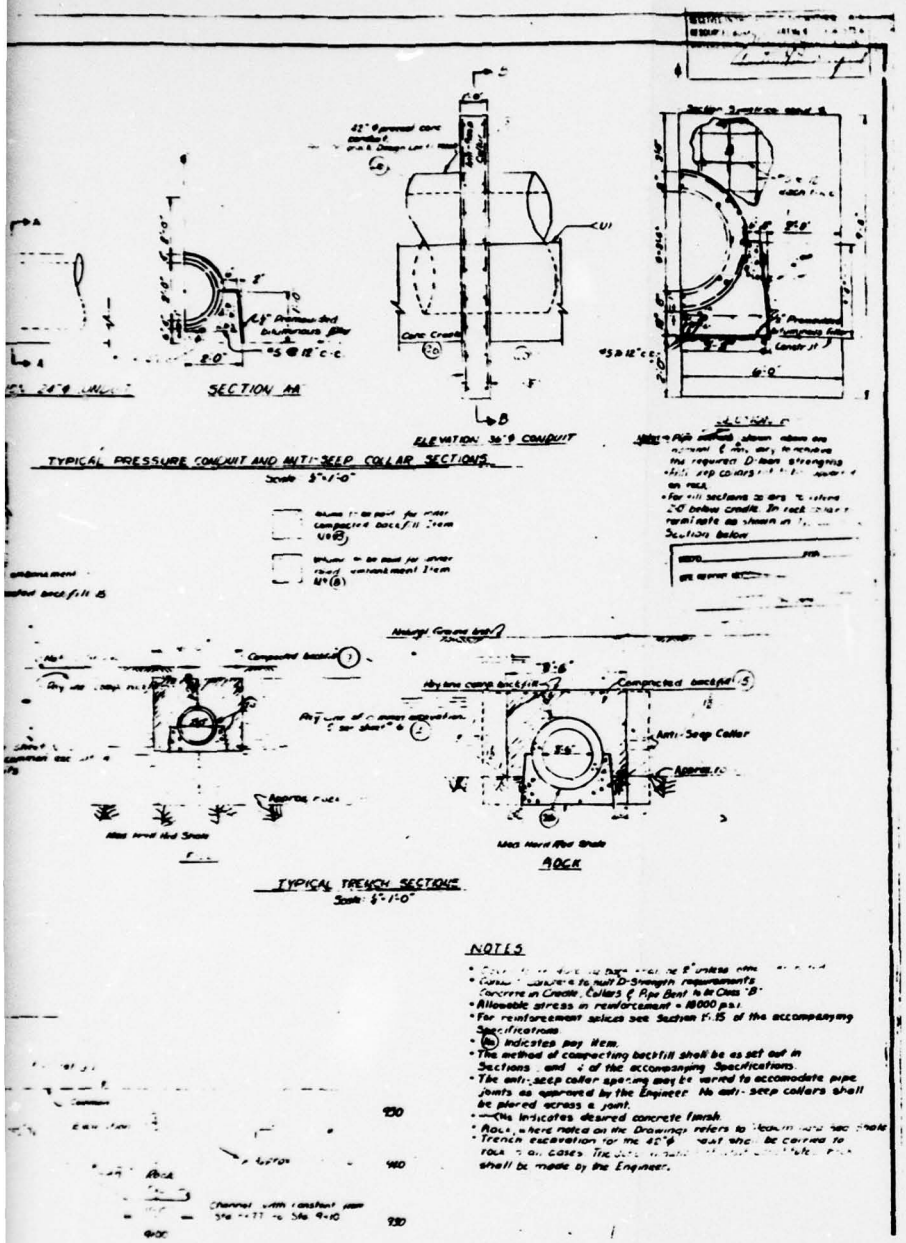
DRAWDOWN STRUCTURE DETAILS
LOCUST CREEK DAM

NAT. ID NO. PA.00699 SCHUYLKILL COUNTY

DATA OBTAINED FROM U.S. DEPT. OF AGRICULTURE, SOIL CONSERVATION SERVICE, DWG. NO. R54:3-1.8 , SHEET 8 OF 10

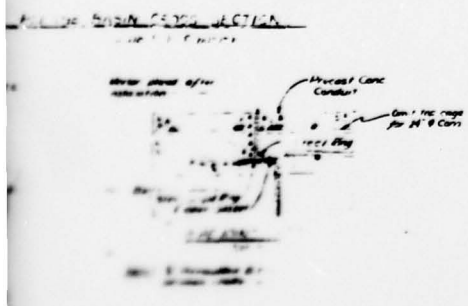
PLATE 5





NOTES

- Concrete shall be Class "B" unless otherwise noted.
- Concrete mixtures to meet D-Strength requirements.
- Concrete in Cradle, Collars & Pipe Bent to be Class "B".
- Allowable stress in reinforcement = 18000 psi.
- For reinforcement splices see Section 9.15 of the accompanying Specifications.
- (36) indicates pay item.
- The method of compacting backfill shall be as set out in Sections ... and ... of the accompanying Specifications.
- The anti-seep collar spacing may be varied to accomodate pipe joints as approved by the Engineer. No anti-seep collars shall be placed across a joint.
- ~~~ this indicates desired concrete finish.
- ROCK, where noted on the Drawings refers to ... rock shall be ...
- Trench excavation for the 42"ø ... shall be carried to ... rock in all cases. The ... shall be made by the Engineer.



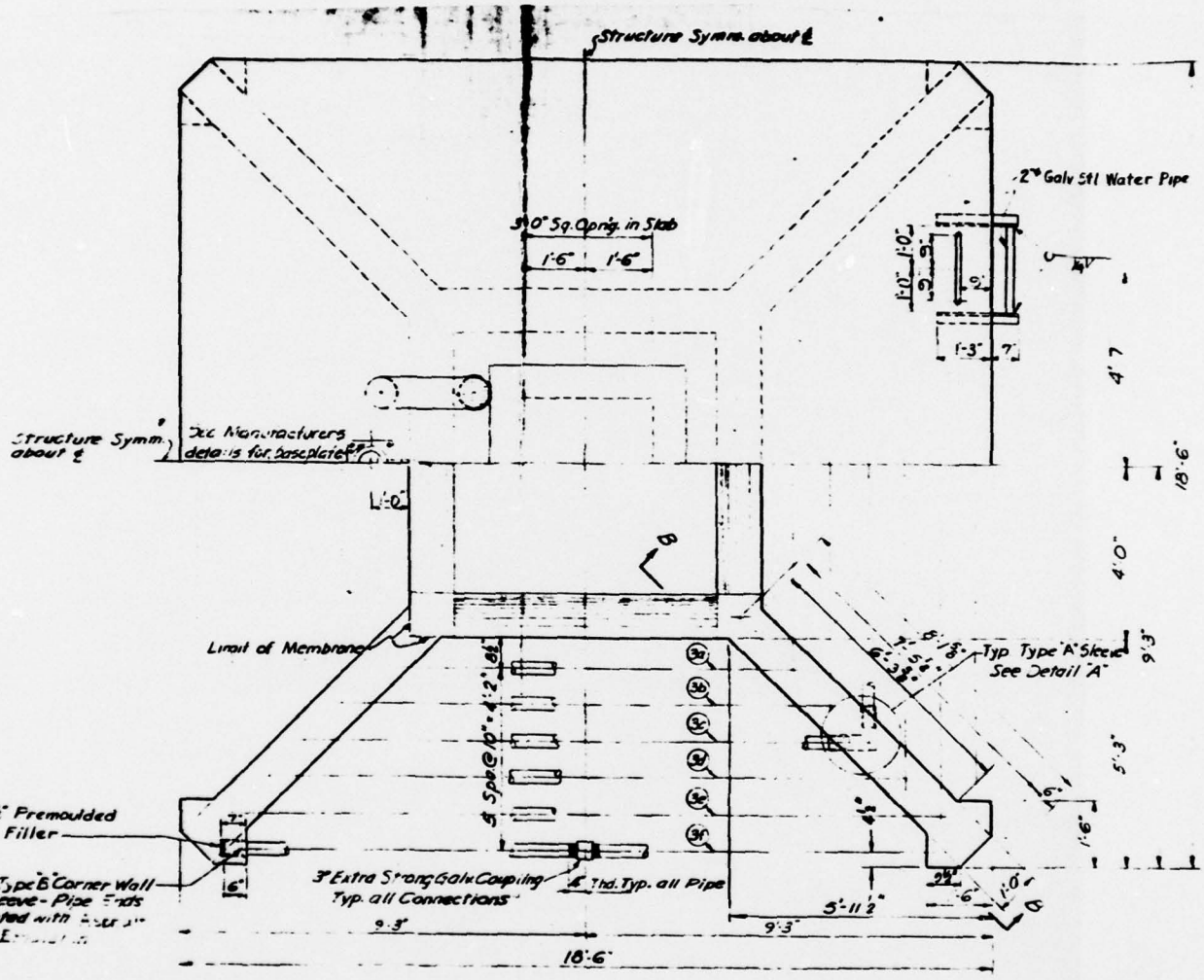
CONDUIT AND PLUNGE POOL DETAILS
LOCUST CREEK DAM

NAT. ID NO. PA.00699 SCHUYLKILL COUNTY

DATA OBTAINED FROM U.S. DEPT. OF AGRICULTURE, SOIL CONSERVATION SERVICE, DWG. NO. R54:3–1. , SHEET 7 OF 10

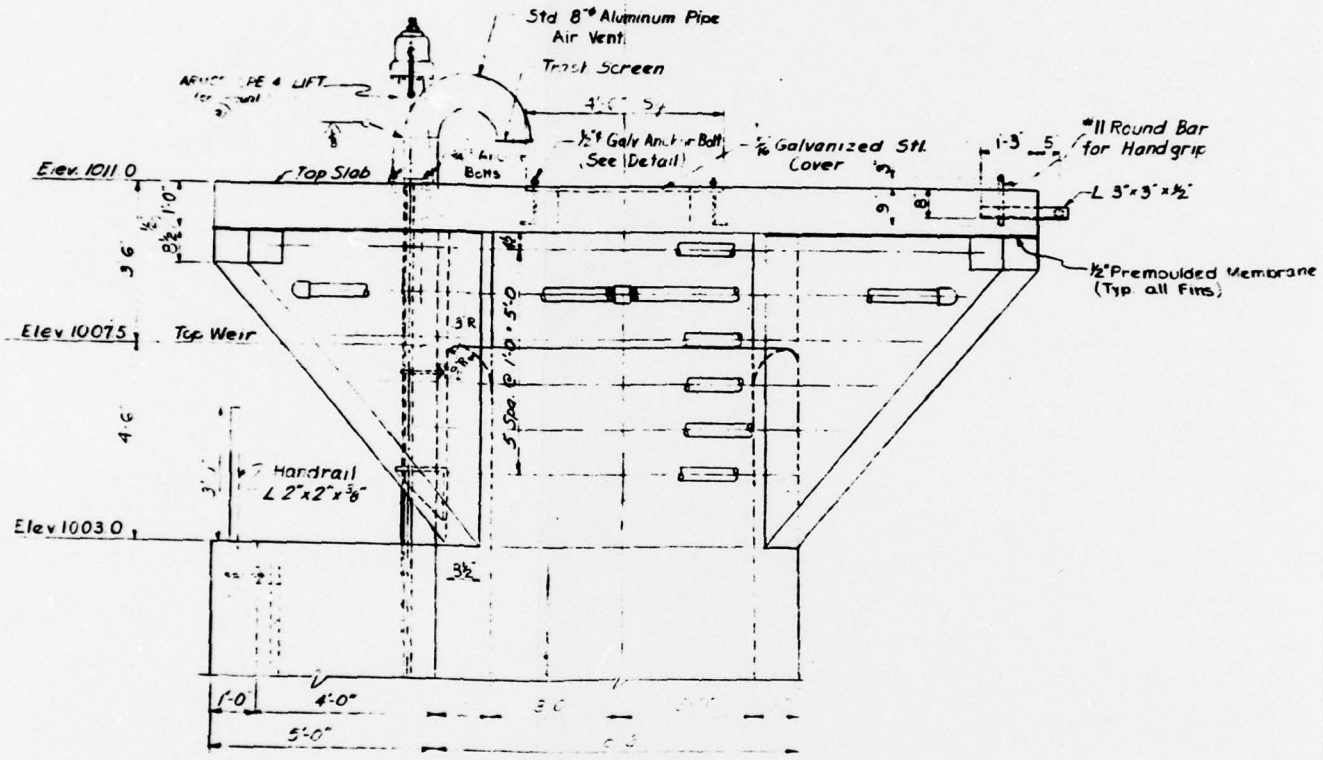
PLATE 6

2



PLAN

SCALE ½" = 1'-0



ELEVATION

SCALE 1"=1'-0"

RISER – ANTI VORTEX DEVICE
LOCUST CREEK DAM

NAT. ID NO. PA.00699 **SCHUYLKILL COUNTY**

DATA OBTAINED FROM U.S. DEPT. OF AGRICULTURE, SOIL CONSERVATION SERVICE, DWG. NO. R54:3–1.10, SHEET 10 OF 10

PLATE 7

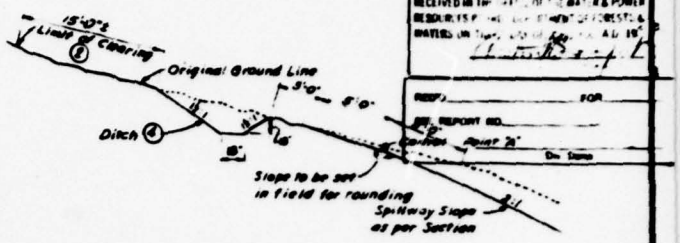
DWG. NO. R 54:3-1.4

SPILLWAY PLAN
Scale 1" = 50'

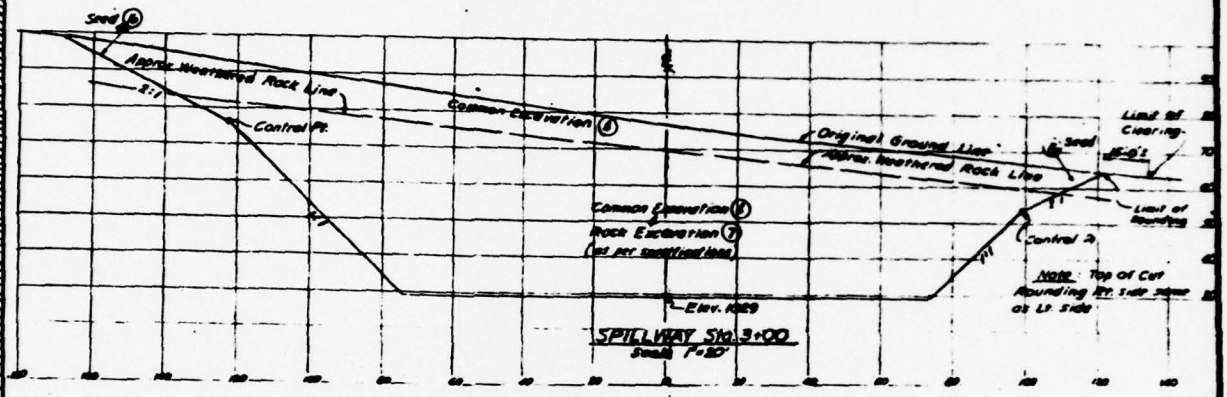
CENTERLINE PROFILE
Scale: Hor. 1" = 50'
Vert. 1" = 50'

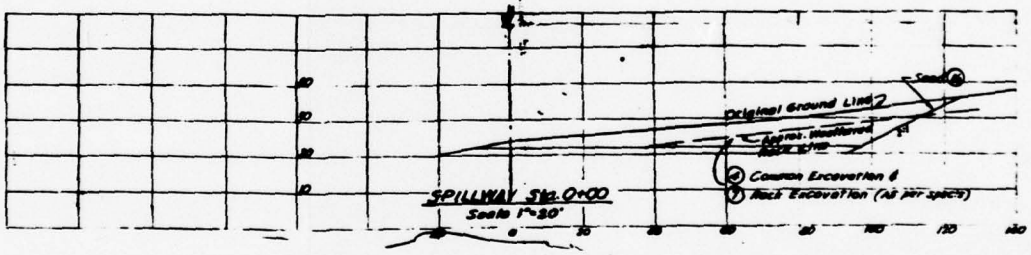
Sta ℄	Control Points			
	Left		Right	
	Offset	Elev.	Offset	Elev.
0+00				
1+00	122	1050.0	112	1046.0
2+00	126	1076.0	104	1050.0
3+00	125	1078.0	100	1053.0
4+00	130	1073.0	99	1052.0
5+00	112	1063.3	89	1040.3
6+00	97	1048.3	—	—
7+00	86	1030.3	—	—

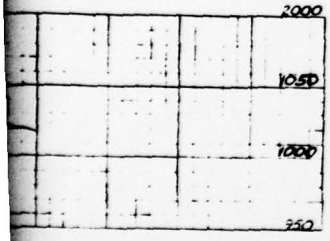
* Control Point to be within rock ; field conditions may require adjustment during construction as determined by the Engineer.



TOP OF CUT TREATMENT - LEFT SIDE
Scale : 1" = 5'-0







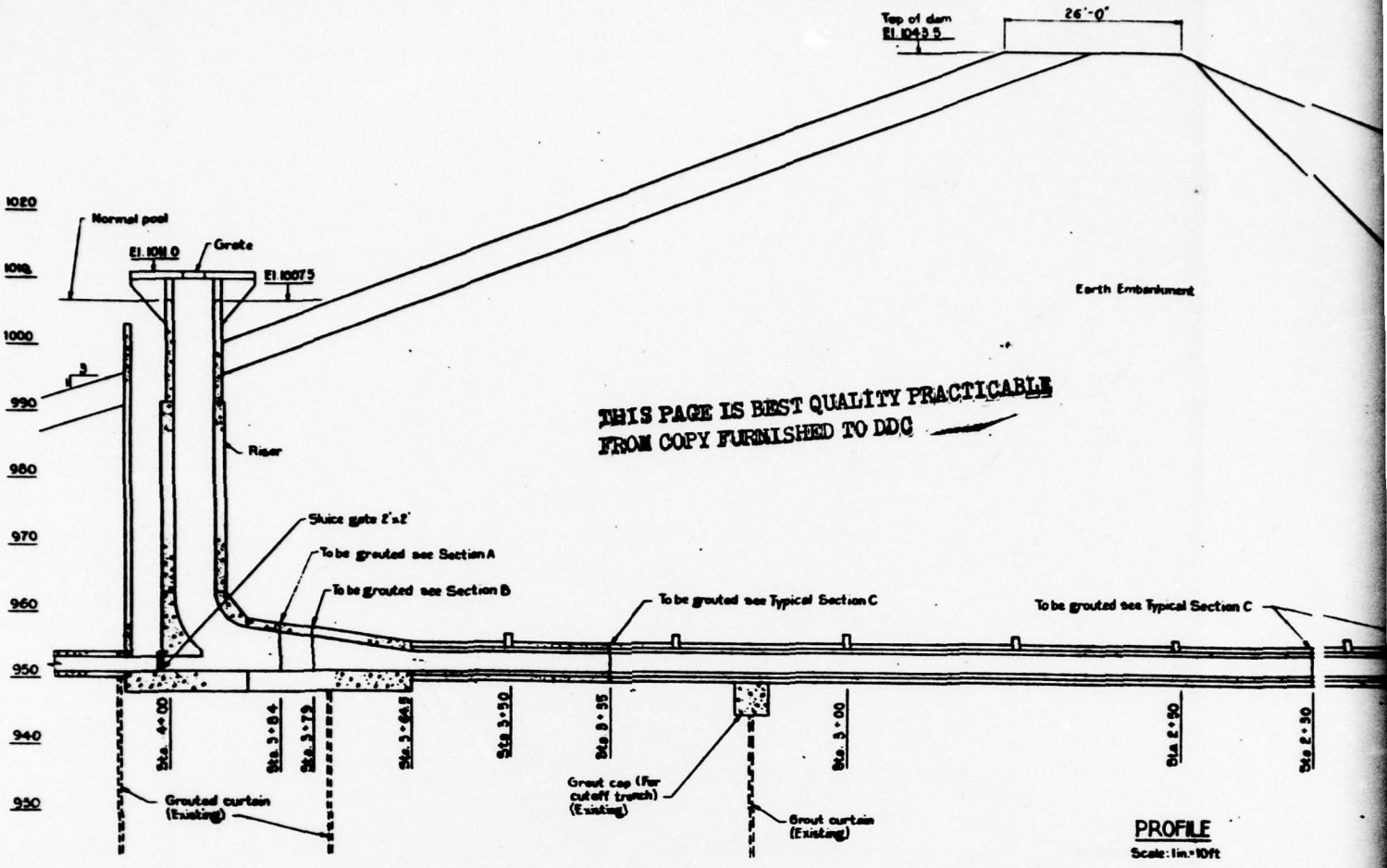
EMERGENCY SPILLWAY
LOCUST CREEK DAM

NAT. ID NO. PA.00699 SCHUYLKILL COUNTY

DATA OBTAINED FROM U.S. DEPT. OF AGRICULTURE, SOIL CONSERVATION SERVICE, DWG. NO. R54:3-1.4 , SHEET 4 OF 10

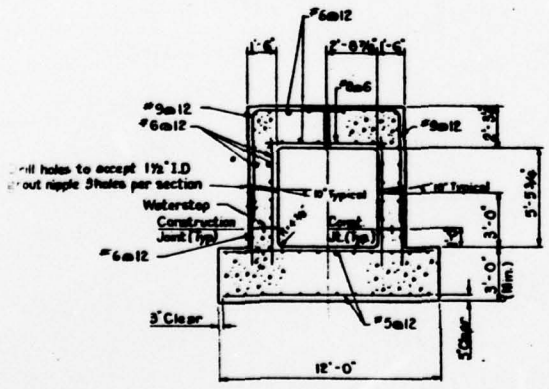
2

PLATE 8



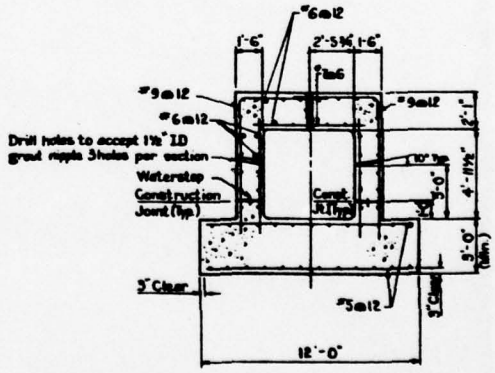
PROFILE

Scale: 1in.=10ft



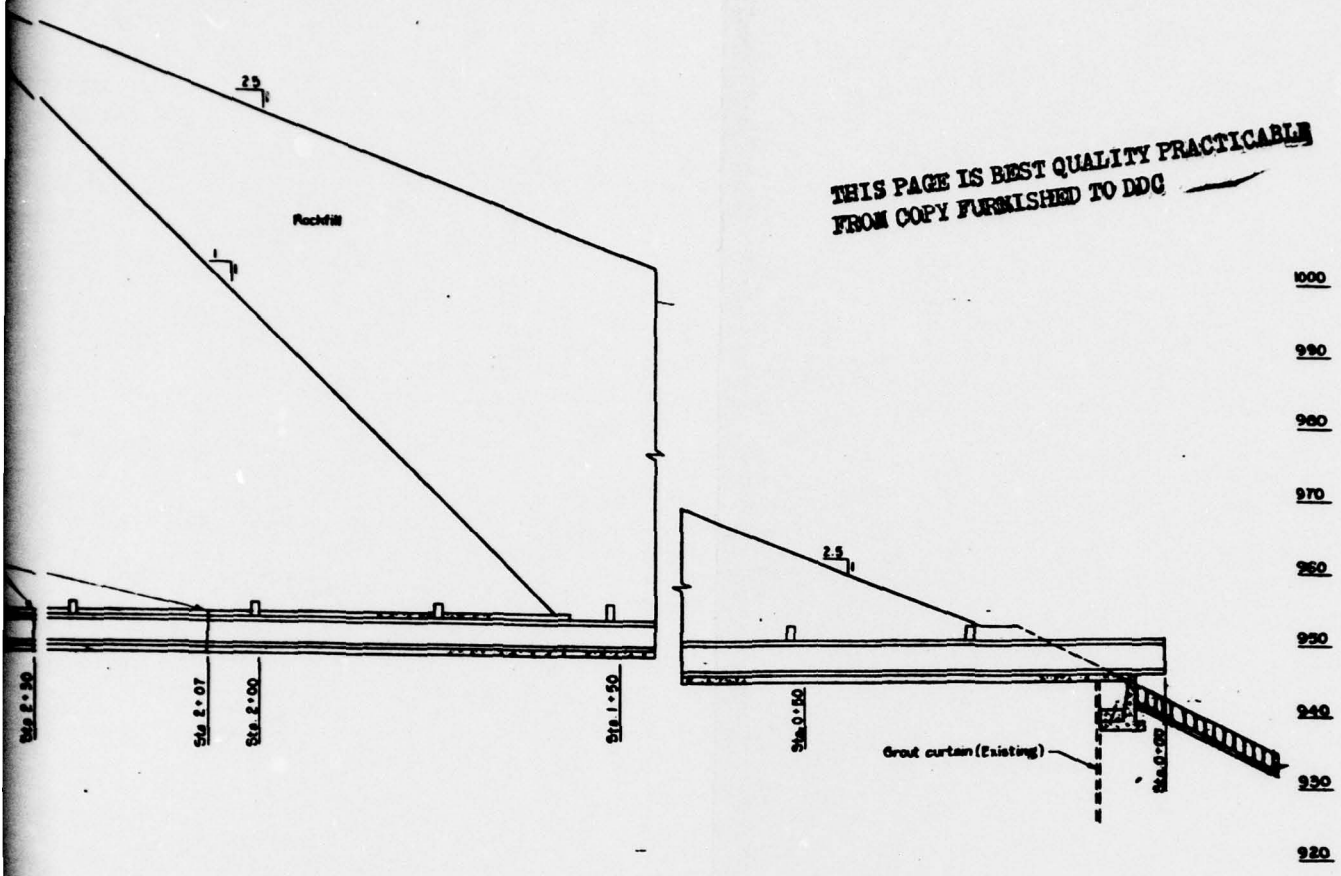
SECTION 'A' - STA 3+84

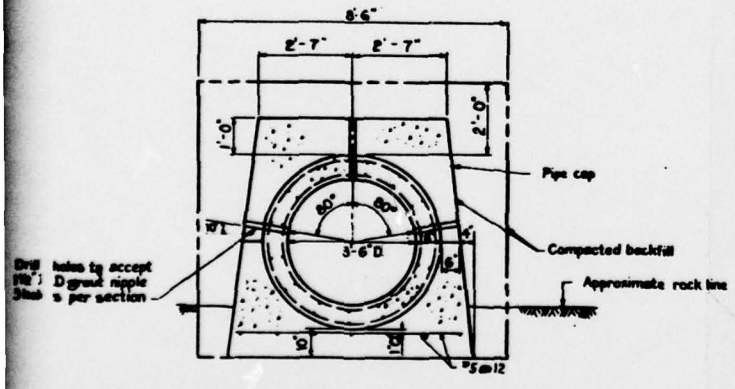
Scale: 1/4 in.=1ft.



SECTION 'B' - STA 3+79

Scale: 1/4 in.=1ft





TYPICAL SECTION 'C' - STA. 3+55 - STA. 2+30 - STA. 2+07
Scale: ½ in. = 1ft

NOTES:

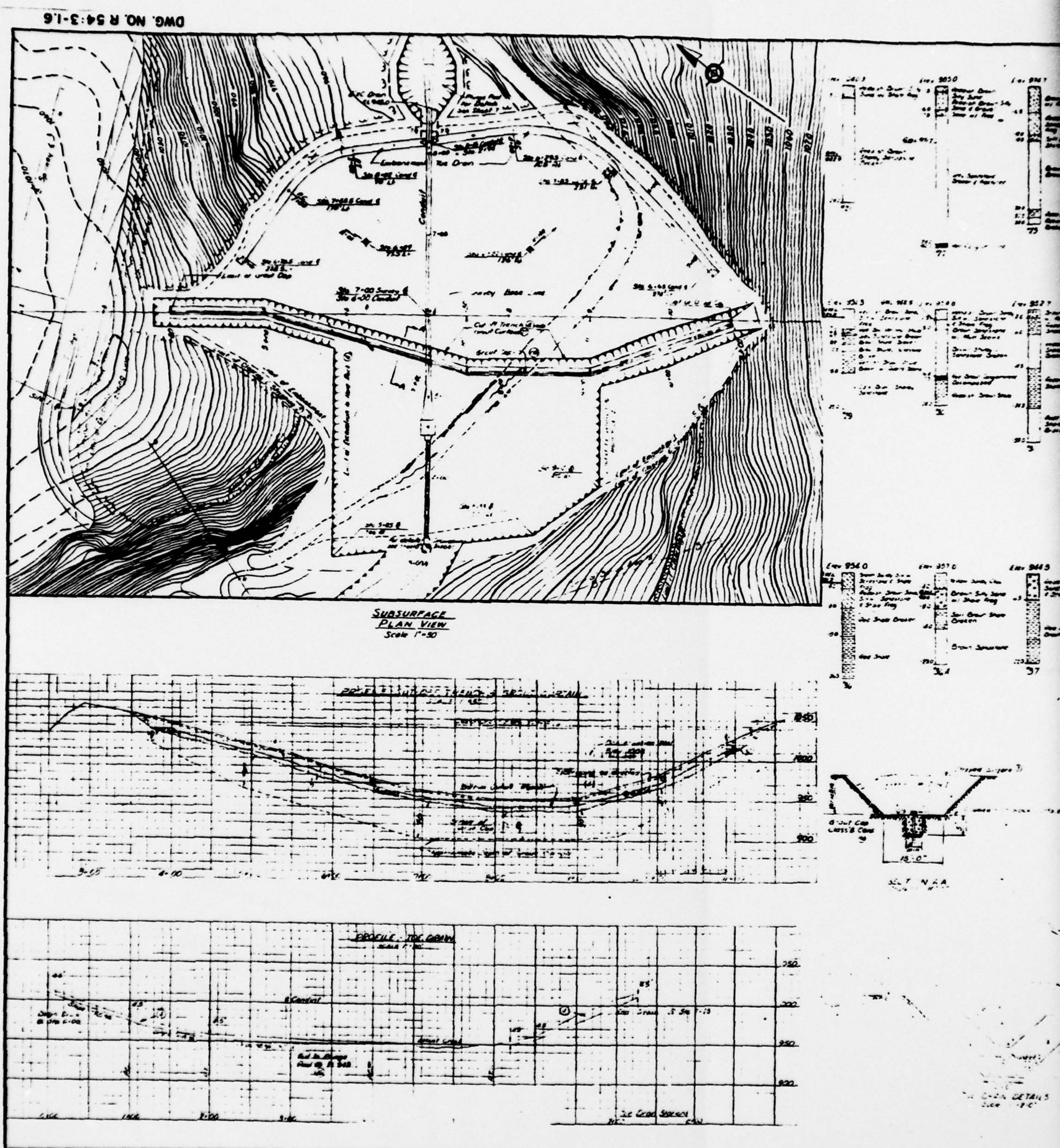
1. Grouting hole pattern shown is tentative and may be adjusted with approval of the Engineer.
2. The sequence of grouting shall be such as to grout the lower holes first and then proceed to the top hole at each section.
3. Additional holes may be required as directed by the Engineer, in case of heavy grout intake.
4. Additional reservoir data can be obtained at this office.

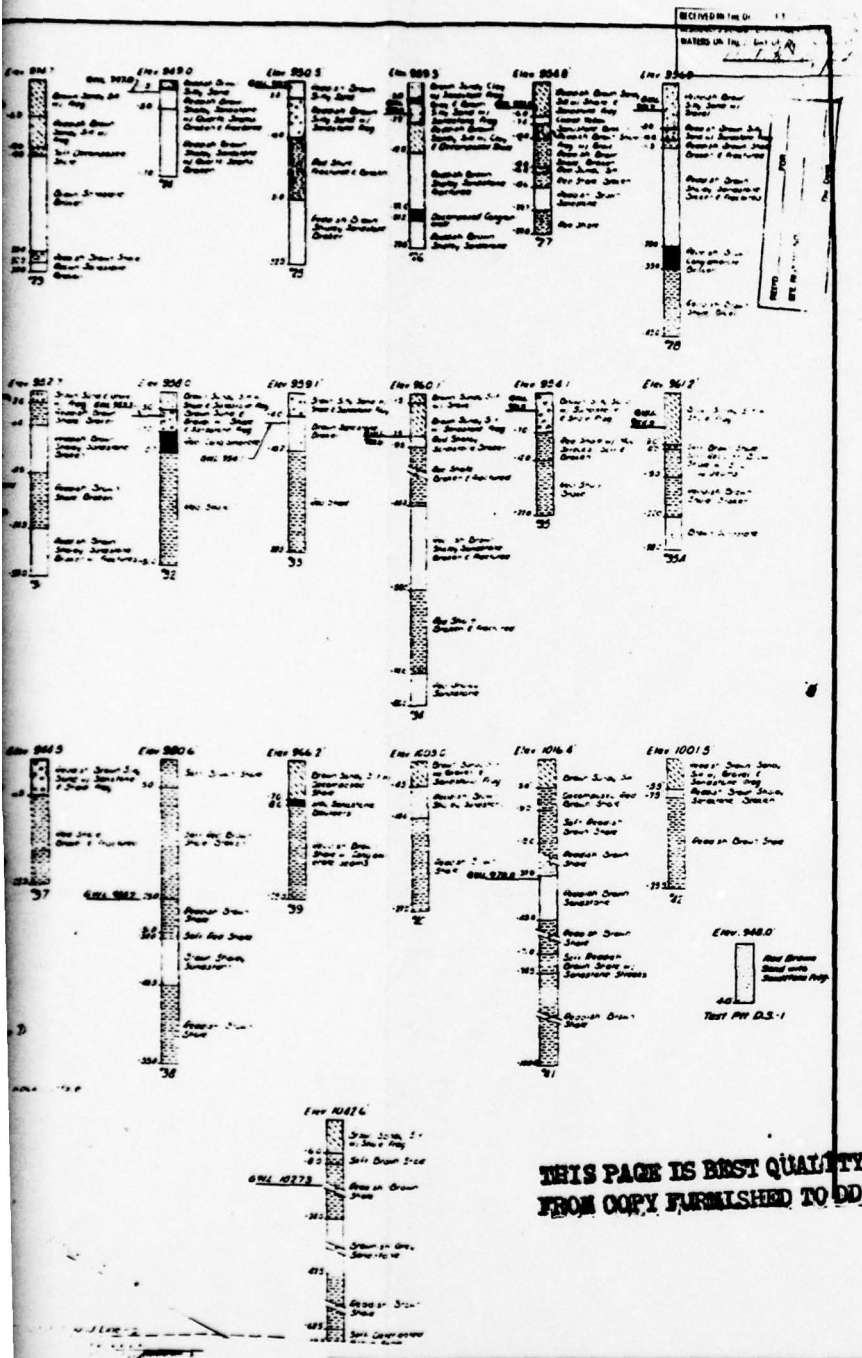
GROUTING OUTLET CONDUIT REPAIR WORK
LOCUST CREEK DAM

NAT. ID NO. PA.00699 **SCHUYLKILL COUNTY**

DATA OBTAINED FROM PA. DEPT. OF ENVIRONMENTAL RESOURCES, OFFICE OF RESOURCE MANAGEMENT, DWG. NO. R54:3–2.1, DATED DEC., 1973

PLATE 9





EMBANKMENT FOUNDATION PLAN
AND BORING LOGS
LOCUST CREEK DAM

NAT. ID NO. PA.00699 **SCHUYLKILL COUNTY**

DATA OBTAINED FROM U.S. DEPT. OF AGRICULTURE, SOIL CONSERVATION SERVICE, DWG. NO. R54:3–1.6 , SHEET 6 OF 10

PLATE 10

APPENDIX

F

SITE GEOLOGY
LOCUST CREEK DAM

Locust Creek Dam is located in the Appalachian Mountain section of the Valley and Ridge Physiographic Province. The bedrock underlying the dam is reported to be composed of the red and brown sandstones, siltstones and shales of the Mississippian age Mauch Chunk Formation (see Plate F-1). In the vicinity of the dam, the Mauch Chunk Formation is bounded on the south-southeast by the conglomerates, sandstones, shales and coal of the Pennsylvanian age Pottsville and Llewellyn Formations (Wood and Arndt, 1973). Bedding in the site area is reported to be variable, with the Carboniferous strata being sharply folded; the fold axes are generally oriented approximatley N 70° E (Lohman, 1957). The area is cut by a number of thrust and high angle normal faults. One of these faults, the south dipping Locust Creek thrust fault, strikes approximately down the center of the reservoir and under the dam structure. Two prominent sets of open, variably spaced joints have been observed: one set striking along the major axes of folding (N 70° E) and dipping at 18° NW, and a second set striking N 20° W and dipping at 82° E (Wood and Arndt, 1975; Sevon, 1975).

Pleistocene age deposits in the site area are reported to be limited to occasional deposits of Pre-Illinoian glacial drift, and in the immediate vicinity of the dam periglacial talus deposits such as those on the north slope of Locust Mountain, on the south side of the dam (Leverett, 1957). These are assumed to have been removed prior to construction of the dam structure.

Downstream seepage should not be a major problem unless the major N 70° E joint set and the Locust Creek thrust fault act as zones of groundwater transport beneath the dam structure, due to the dam being constructed perpendicular to these features.

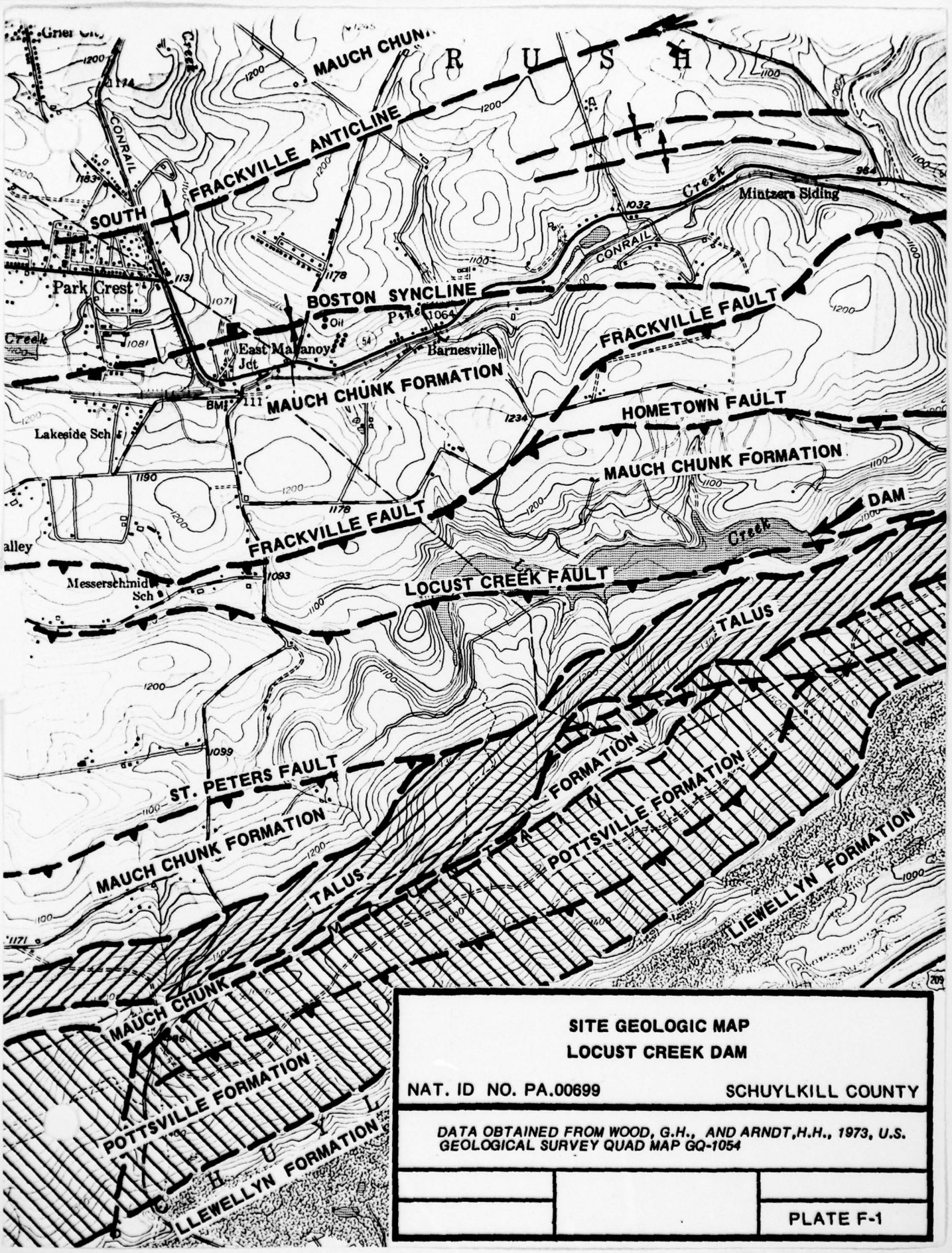
References:

1. *Leverett, F., 1957, Glacial Deposits outside the Wisconsin Terminal Moraine in Pennsylvania: Pa. Geol. Survey, 4th Series, Bull. G-7, 123 p.*

2. *Lohman, S.W., 1957, Ground Water in Northeastern Pennsylvania: Pa. Geol. Survey, 4th Series, Bull. W-4, 312 p.*

3. *Sevon, S.D., 1975, Geology and Mineral Resources of the Christmans and Pohopoco Mountain Quadrangles, Carbon and Monroe Counties, Pennsylvania: Pa. Geol. Survey Atlas 195 ab, Plate 1, 1:24,000.*

4. *Wood, G.H. and Arndt, H.H., 1973, Geologic Map of the Delano Quadrangle, Schuylkill County, Pennsylvania: USGS Geologic Map GQ-1054, a:24,000.*



SITE GEOLOGIC MAP
LOCUST CREEK DAM

NAT. ID NO. PA.00699 SCHUYLKILL COUNTY

DATA OBTAINED FROM WOOD, G.H., AND ARNDT, H.H., 1973, U.S. GEOLOGICAL SURVEY QUAD MAP GQ-1054

PLATE F-1